# FOURTH SYMPOSIUM
# ON OILS, FATS &
# ALLIED PRODUCTS

CFTRI-MYSORE
4030
Fourth symposium...

Acc. No. 4030

4030 ① oilseeds ② oil extraction ③ oil refining ④ vanaspathi ⑤ vitamin A ⑥ antioxidants ⑦ fatty acids ⑧ oil analysis ⑨ soaps ⑩ detergents ⑪ surface coatings ⑫ insect pests ⑬ microbial farming ⑭ fat production

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CFTRI-MYSORE
4030
Fourth symposium.

5. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants' Chamber Ltd., Bombay).

**Sub-Committee F.** For Marine Oils and Products.

1. Mr. S. M. Arsiwala, (Department of Fisheries, Government of Bombay) — **Convenor.**
2. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants' Chamber Ltd., Bombay).

**Editorial Committee.** For the publication of Symposium and Exhibition Number.

1. Dr. J. G. Kane, (Department of Chemical Technology, University of Bombay) — **Convenor.**
2. Dr. G. S. Hattiangdi, (Messrs. Hindustan Vanaspati Manufacturing Co. Ltd., Bombay).
3. Dr. B. G. Gunde, (Messrs. Tata Oil Mills Co. Ltd., Bombay).
4. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants' Chamber Ltd., Bombay).
5. Mr. D. N. Dutia, (Oil Merchants' Chamber Ltd., Bombay).

# ACKNOWLEDGEMENT

It should be mentioned at the outset that the Oil Merchants' Chamb Ltd., Bombay, which had organised this Symposium and Exhibition, w merged subsequently with the Bombay Oilseeds and Oils Exchange Ltd. a result, although the beginning of this volume commenced with the form institution, it is the latter body which now has the pleasure in presenting th to the public.

Various committees were set up for ensuring the success of the Symp sium and Exhibition, and the organisers are very grateful to the differe individuals who consented to be members of these committees. Complet compositions of the committees are given elsewhere. Special mention oug to be made of the Editorial Committee without whose constant encourag ment and support this volume would not have been practicable. Opportunit is also taken to record vary gratefully the unrelenting services of Dr. J. Kane, in humble appreciation of which a special Gold Medal was presente to him at the conclusion of the Symposium.

Valuable co-operation in varius matters was offered by the Indian Centr Oilseeds Committee, Hyderabad, the National Chemical Laboratory of Indi Poona, the Sir J. J. School of Arts, Bombay, the Department of Chemic Technology, University of Bombay, the Har-court Butler Technological Inst tute, Kanpur, the Department of Fisheries, Government of Bombay, Messr Hindustan Vanaspati Manufacturing Co. Ltd., Bombay, Messrs. Tata Oil Mill Co. Ltd., Bombay, and several other Government and private institutions i organising the Symposium and Exhibition; this is gratefully acknowledged.

All the twelve charts and flowsheets given at the end of this volum were prepared specially for the Exhibition. Of these, six were contribute by Messrs. Hindustan Vanaspati Manufacturing Co. Ltd., (now M/s Hindusta Lever Ltd.,) Bombay, three by Messrs Tata Oil Mills Co. Ltd., Bombay, an rest were produced by the Applied Art Section of the Sir J. J. School of Art Bombay, on data provided by the Editorial Committee. To all these institu tions, the publishers of this volume are grateful not only for displaying th charts and flowsheets at the Exhibition but also for permission to publish the in this volume.

Our grateful thanks are also due to Shri Ratilal M. Gandhi, Preside and Shri Tulsidas M. Vishram, Hon. Secretary, of the Oil Merchants' Chambe Ltd., Bombay, for their indefatigable organisational work and to the othe staff of the Chamber for their willing co-operation.

We are grateful to the Indian Central Oilseeds Committee. Ministry o Agriculture, Government of India, for a munificent grant for the publicatio of this volume.

Finally, the publishers wish to offer their profound apologies for the ver late publication of this volume which resulted partly from the unsettled stat of affairs consequent upon the merger of the Oil Merchants' Chamber Ltd. Bombay, with the Bombay Oilseeds and Oils Exchange Ltd., Bombay.

# THE OIL MERCHANTS' CHAMBER LTD.

## SYMPOSIUM & EXHIBITION ON OILS, FATS & ALLIED PRODUCTS

GROUP PHOTO

Place : Resham Bhavan,
Churchgate,

Date : 31-10-1955
To

# FOUR FREEDOMS

THE EDIBLE OILSEEDS GIVE YOU **FREEDOM FROM HUNGER.**

THE OIL IN THE LAMP GIVES YOU **FREEDOM FROM DARKNESS.**

THE SOAP FROM THE OIL GIVES YOU **FREEDOM FROM DIRT.**

THE PAINT FROM THE OIL GIVES YOU **FREEDOM FROM WEAR.**

## IE FOUTH SYMPOSIUM & EXHIBITION ON OILS, FATS and ALLIED PRODUCTS

## SUMMARY OF THE PROCEEDINGS

Shri K. D. Malaviya, Union Minister for Natural Resources, who was to ve inaugurated the session was unable to be present owing to unforeseen cumstances and Shri Shantilal Shah, Minister for Health and Labour, vernment of Bombay, very generously consented to deputise on behalf of ri K. D. Malaviya.

In the course of his inaugural address, Shri Shantilal Shah referred to the owing menace of the adulteration of ghee with vanaspati and called upon e industry as well as the scientists to find out ways and means of preventing ch adulteration. He suggested that efforts should be made to explore the ssibility of forming an All-India Contract for the purposes of trading in oils d oilseeds, adding that the question of determinig a standard contract in the port trade was also worth consideration. Shri Shah welcomed the idea of anging the Symposium and Exhibition as a means of acquainting the public th the results of the work of the scientists and said that the trade and indus- should make this a regular feature. He pointed out that it was necessary to ermine whether the production of oils and oilseeds in the country should increased in view of India's position as a leading exporter of these commo- ies. Problems such as the improvement in the quality of oils and oilseeds, ir composition and the requirements of transport also deserve close attention the business community and the authorities concerned.

Welcoming the guests, Shri Ratilal M. Gandhi, President of the Oil Mer- ants' Chamber Ltd., Bombay, speaking earlier, explained the objectives of e Symposium and Exhibition, and said that the oleaginous wealth of the untry should be scientifically exploited and economically developed for the richment of the national economy. He expressed pleasure that the occasion d attracted international attention as evident from the large number of exhi- s, samples and papers received for the Symposium and Exhibition. He pressed the thanks of the Chamber to those institutions, Government depart- nts, eminent scientists and technologists who had co-operated with the amber in organising the Symposium and Exhibition, particularly the latter ich was the first of its kind.

Shri Naval H. Tata, President, Central Organisation for Oil Industry and ade, Bombay, who presided over the Symposium and Exhibition Session said, er alia, that India, as an exporting nation, should have her own standard ntracts for export trade in vegetable oils. He also made a plea for having re tankers of different sizes in our national fleet of mercantile marine to vide further impetus to our export trade of bulk vegetable oils. He urged

the Government to expedite their decision regarding forward trading in v
table oils so that, in the impending busy season, facilities for organised
genuine forward trading in oils could be available to the trade. He sugg
that they should aim at exporting composite cattle feed and manure in
ultimate form, instead of exporting raw oilcake as such. Proceeding fur
he made a plea that the less-known oilseeds and oils should be subjecte
research at different research institutions and efforts should be intensifie
develop various possible uses of products and by-products therefrom so a
enable commercial utilization on a wider scale. He also suggested th
National Laboratory for Oils, Fats & Allied Products be established in
country to promote research in this field. He felt that improvements in
extraction methods used in the country deserved high priority.

Shri Tulsidas M. Vishram, Honorary Secretary of the Chamber then
out messages from eminent persons in India and abroad wishing the Sym
sium and Exhibition every success.

Dr. G. I. Finch, Director, National Chemical Laboratory of India, Po
addressing the gathering on this occasion, made a plea for closer co-opera
and better contacts between scientists and industrialists.

Shri Vallabhdas V. Mariwala, Vice President of the Chamber, propose
vote of thanks to Shri Shantilal Shah, which was carried with acclamation

The proceedings of the Symposium commenced with Dr. B. P. Godre
the Chair on the first day i.e. the 31st October 1955; on the second day i.e.
1st November 1955, Dr. J. S. Badami and Dr. J. S. Aggarwal were reques
to act as a Chairman at the morning and afternoon sessions, respectiv
Discussion during the Symposium was very lively and aroused keen inte
among those present.

The participants of the Symposium also unanimously adopted a resolut
stating that the increasing importance of the economy of oils, fats and all
products in our country required constant vigilance to ensure further devel
ment of research work in this field. It also suggested that a high powe
Standing Committee consisting of the distinguished scientists, technolog
and research workers should be constituted to look after this aspect of
economy, and requested the Indian Central Oilseeds Committee to make s
able arrangements in this respect so that continued guidance from scient
might be made available to Government departments, industry and ot
institutions engaged in such programmes of work.

In the concluding stages of the Symposium, special Gold Medals w
awarded on behalf of the Chamber to Dr. J. C. Kane, Dr. J. S. Aggarwal,
K. K. Dole and Mr. R. C. Sheth for their co-operation and assistance in or
nising the Symposium and Exhibition, and for ensuring their success.

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# COMMITTEES AND MEMBERS THEREOF FOR THE SYMPOSIUM AND EXHIBITION

**echnical Committee :**

1. Dr. B. P. Godrej, (Messrs. Godrej Soaps Ltd., Bombay) — **Convenor**
2. Dr. J. S. Badami, (Messrs. Swastik Oil Mills Ltd., Bombay).
3. Dr. J. G. Kane, (Department of Chemical Technology, University of Bombay).
4. Mr. D. M. Gangolli, (Messrs. D. M. Gangolli & Co., Bombay).
5. Dr. J. S. Aggarwal, (National Chemical Laboratory of India, Poona).
6. Dr. K. K. Dole, (Fergusson College, Poona).
   Mr. T. M. Vishram and Mr. R. C. Sheth (Hon. Secretary and Secretary respectively, Oil Merchants' Chamber. Ltd.,) were co-opted.

**aper Committee:**

1. Dr. J. G. Kane, (Department of Chemical Technology, University of Bombay) — **Convenor.**
2. Mr. N. R. Kamath, (Department of Chemical Technology, University of Bombay).
3. Dr. D. Rebello, (Department of Chemical Technology, University of Bombay).
4. Mr. K. B. Kanekar, (Chemist, Oil Merchants' Chamber Ltd., Bombay).
5. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants' Chamber Ltd., Bombay).

**xhibition Committee:**

1. Dr. K. K. Dole, (Ferguson College, Poona) — **Convenor.**
2. Prof. J. C. Bahl, (Principal, Siddharth College of Commerce, Bombay).
3. Dr. J. S. Aggarwal, (National Chemical Laboratory of India, Poona).
4. Shri Hansraj Mulji, (Ex-Director, Oil Merchants' Chamber Ltd. Bombay).
5. Shri Chhaganlal Velji (Director, Oil Merchants' Chamber, Ltd., Bombay).
6. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants' Chamber Ltd., Bombay).

**ub-Committee A.** For plants & Oilseeds of various kinds and their analytical data.

1. Dr. J. S. Aggarwal, (National Chemical Laboratory of India, Poona)— **Convenor.**
2. Mr. G. B. Devdikar, (Maharashtra Association for Cultivation of Science, Poona) — **Convenor.**

3. Shri Bhogilal Purshottam, (Director, Oil Merchants' Chamber Ltd. Bombay).
4. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants Chamber Ltd., Bombay).

**Sub-Committee B.** For oils of various kinds & their analytical data.

1. Dr. J. S. Aggarwal, (National Chemical Laboratory of India, Poona) — **Convenor.**
2. Shri P. J. Bhatt, (Ex-Member of the Journal Committee of the Oi Merchants' Chamber Ltd., Bombay).
3. Mr. P. J. Rau, (Chemist, Oil Merchants' Chamber Ltd., Bombay).
4. Mr. K. H. Thaker, (Technical Assistant and Chemist, Oil Merchants Chamber, Ltd., Bombay).

**Sub-Committee C.** For statistical charts, graphs and pictorial representation having bearing on oils, fats and allied products.

1. Mr. V. N. Adarkar, } (Sir J. J. School of Arts, Bombay) — **Convenors**
2. Mr. V. V. Deo, }
3. Prof. J. C. Bahl, (Principal, Siddharth College of Commerce, Bombay).
4. Mr. K. N. Mehta, (Messrs. Bombay Oil Industries Ltd., Bombay).
5. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchants Chamber Ltd., Bombay).

   Mr. R. C. Sheth, Secretary Oil Merchants' Chamber Ltd., Bombay wa later on co-opted.

**Sub-Committee D.** For machinery & spare parts for oils and allied industries

1. Mr. M. H. Shah, (Messrs. Voltas Ltd., Bombay) — **Convenor.**
2. Dr. W. D. Korde, (Consultant — Bombay).
3. Mr. N. S. Sarvottam, (Industrial Agricultural Engineering Co., Bombay
4. Mr. A. P. Bhat, (Messrs. Jyoti Ltd., Baroda).
5. Mr. K. H. Thakar, (Technical Assistant and Chemist, Oil Merchant Chamber Ltd., Bombay).

**Sub-Committee E.** For publications and periodicals on oils, fats & allied products; pilot plant; demonstration of analytical and scientifi apparatus.

1. Dr. D. Rebello, (Department of Chemical Technology, University c Bombay) — **Convenor.**
2. Dr. J. S. Badami, (Messrs. Swastik Oil Mills Ltd., Bombay).
3. Dr. G. S. Hattiangdi, (Messrs. Hindustan Vanaspati Manufacturing C Ltd., Bombay).
4. Dr. B. G. Gunde, (Messrs. Tata Oil Mills Co. Ltd., Bombay).

A group photograph was taken on the terrace of Resham Bhavan and the amber was "At Home" to the guests at a reception held at the Taj Mahal tel, Bombay.

The Exhibition, which was organised along with the Symposium was very ll attended and its tenure was extended by a week because of pressing mands from various quarters.

All the Charts and exhibits, except those received from certain private titutions and Government departments were presented to the Museum of e Indian Central Oilseeds Committee, Hyderabad.

# ADDRESS

By

## SHRI KESHAVA DEVA MALAVIYA,

Minister of Natural Resources, Government of India.

On the occasion of inauguration by him of a Symposium and Exhibition
Oils, Fats and Allied Products organised by The Oil Merchants' Chamber
Ltd. at Resham Bhavan Hall, Bombay on 31st Oct. 1955 at 10 a.m.

Dear Friends :

It is my great privilege to be with you and open this important symposiu and exhibition on oils, fats and allied products. You all know that India hold a pre-eminent position amongst the oilseeds producing countries of the worl and makes an important contribution to the world's oilseed crushing industry It is the nature alone that has endowed our country with the growth an production of oilseeds and other oil bearing materials. India, being one of th largest oilseed producing countries of the world, possessed a predominatin position in the oilseeds trade. The vegetable oils play a magnificent role in th economy of a country. It can, however, be substantiated by the facts tha oilseeds exports constitute a sizeable proportion of total Indian foreign trade.

2. The subject of study of oils and oilseeds is the most vital one, a besides its industrial application, oil forms an extensive source of fats for the human consumption, while the oilcake is a nourishing cattle feed and is also used for manurial purposes. Apart from satisfying the indigenous food and industrial requirements, a large proporation of oil and oilseeds are exported every year and earn a fairly large amount of foreign exchange. India supplies one fifth of the world's oilseeds and other oleaginous material. There has been an increasing demand for oilseeds both for edible and industrial purposes within the country and also for export purposes. In the recent years, the increase in the requirements of oilseeds has been enormous. Oilseeds and oils find extremely important use as raw materials for a number of industries; such as hydrogenated fats, soaps, cosmetics, hair oils, paints and varnishes and a wide variety of products, like linoleum, oil cloth etc.

3. The problem before us is very common and well known; as it is not difficult to conceive that an agriculturist has to perform the duty of extensive cultivation of oilseeds while the man of commerce has to find suitable market for the same. The industrialist, on the other hand, has to see to the utilisation of seeds and undertake oil expressing and dispose off oil and oilcake in a profitable manner. The scientist and the technologist, in turn, has to evolve the efficient and economic methods of working and utilisation of the oils and oilcakes in their proper fields. There is no doubt that the oilseed crushing industry has made sufficient progress during the last twenty-five years and the bulk of

lseeds grown in India are at present crushed in the country itself, the lcakes being thus available for fodder and manurial purposes. The installation f solvent extraction plants is an important step towards the exploitation of digenous raw materials in an economic way but the supply of cheap solvents r this purpose is yet a problem to be solved. In due course, it is to be hoped at Government's energetic search for mineral oil in India would soon lead to digenous production of cheap solvents.

4. The subject of oil and oilseeds is not merely national problem but it as an international significance. It is not difficult to appreciate the importance f this subject as the production of food and allied products is by far the large dustry in the world and serves the nutritional needs of the community. It s gratifying to note that experts in their respective fields have assembled here o collectively exchange amongst themselves the benefits of knowledge and xperience which every one has gained from the problem handled by each ne of them individually.

5. This symposium has provided an opportunity to the industrialists, usinessmen, scientists and technologists to discuss problems of common interest nd ultimately promote and foster applied research in the right direction to elp the cause of the oil and allied industries in the country. I am, indeed, onfident that for the efficient development of the industry it is extremely ssential to afford adequate facilities to the scientific workers to enable them o tackle problems relating to the utilisation of these products within the ountry. With the industrial awakening and the programme of countrywide ndustrialisation, it would perhaps seem necessary to devote more attention o exports of manufactured products from oils and oilseeds instead of exporting he same as base raw materials. The basic idea of assembling here today is o stimulate interest in the scientific and technological production of the oils nd fat industry.

6. It may be quite relevant to mention here that in India there are many inds of less known oilseeds awaiting exploitation and to which the next Five-Year Plan is directing attention. In fact, we are all keen to see that oil and ilseed industry is further strengthened and is given the due importance.

7. I am sure that matters of prime interest to the oil production, will be scussed in many papers, to be brought before us. The contributors of these apers must be thanked for their co-operation. The wide range of oil bearing eeds and other products that you would see in the exhibition has certainly omething to add to our knowledge and information on the subject.

8. In the end, I take great pleasure in inaugurating this symposium and pening this exhibition and I wish it a great success.

# WELCOME ADDRESS BY
## SHRI RATILAL M. GANDHI, PRESIDENT.
## OIL MERCHANTS' CHAMBER LTD. (CONVENORS)

**At Symposium & Exhibition on Oils, Fats & Allied Products**

At Resham Bhavan, Bombay,

on 31st October & 1st November, 1955.

It is my pleasure and privilege to extend to you all a hearty and cordial welcome on behalf of this Chamber to the Symposium and Exhibition on Oils, Fats and Allied Products, that have been organised by us. As most of you might be aware, the Chamber had organised a similar Symposium during February 1953; but this time we have enlarged the scope of the Symposium by organising an Exhibition alongwith it with a view to spot-light the important part played by oils, fats, etc., in our national economy.

It is indeed in fitness of things that at this Symposium and Exhibition which are attended by many eminent industrialinsts, scientists, technologists and research workers in the field of oils, fats, etc., from different parts of the country, we should have in our midst Shri K. D. Malaviya, Minister for Natural Resources, Government of India, to inaugurate the Symposium alongwith the Exhibition and give us all the benefit of his valuable advice. We are grateful to you, Sir, for having acceded to our request and spared your valuable time by coming over here so soon after your recent visit to Russia, U. K., etc.

We are indeed fortunate in having at the helm of this Symposium, a distinguished President, in the person of Shri Naval H. Tata, the President, Central Organisation for Oil Industry and Trade. As we all know, Shri Naval H. Tata comes from the House of Tatas, who have contributed to a great extent towards the industrial development of our country and are one of the leading manufacturers in the field of oils, fats, soaps, etc. I am sure that his first hand practical experience and close acquaintance with the problems confronting these industries will prove of considerable help and guidance in the deliberations of this learned gathering. We are thankful to you, Sir, for having accepted our invitation to preside over the Symposium as well as the Exhibition inauguration.

I would also express our thanks to the distinguished visitors, who have graced this occasion with their presence and evinced keen interest in the Symposium and the Exhibition as well as to all those very eminent scientists and other leading personalities in different walks of life both in India and abroad who have very kindly sent us inspiring messages on this occasion.

Let me accord our most cordial welcome to the delegates, many of whom are distinguished scientists, technologists and research workers, who have very enthusiastically responded to our invitation and taken the troubles to come over here from different parts of the country to present Papers on interesting topics and many important research works. We have received as many as 70 papers and that shows the extent of interest evinced by all concerned in the Symposium and the scope of research works in this field.

With our own limitations, we have emboldened ourselves to organise an Exhibition alongwith the Symposium. We are grateful to Departments of Agriculture Industry, Forest and Fisheries of various State Governments, many research institutions like, The National Chemical Laboratory of India, Poona, Central Food Technological Research Institute, Mysore, Harcourt Butler Technological Institute, Kanpur, Central Laboratories for Scientific and Industrial Research, Hyderabad (Dn.), etc., as well as Indian Central Oilseeds Committee, Hyderabad, Indian Central Coconut Committee and other bodies who have extended their valuable co-operation to the Chamber by sending Papers as well as many interesting and educative exhibits, samples of a variety of less known oilseeds and oils, their products and by-products, derived after extensive research. Many manufacturing concerns such as Hindustan Vanaspati Manufacturing Co., Ltd., Tata Oil Mills Ltd., Swastik Oil Mills Ltd., Godrej Soaps Ltd., etc., have been good enough to extend their co-operation to the Exhibition by sending exhibits and our thanks are also due to all of them.

It is gratifying to note that the Symposium as well as the Exhibition have provided common ground for the business community as well as the scientists to work together for common objectives i. e. advancement of knowledge and development of research in this field. We have been fortunate enough to receive the unstinted co-operation, whole-hearted support and valuable guidance from the galaxy of eminent scientists and technologists in the field of oils, fats, etc., such as Dr. B. P. Godrej of Godrej Soaps Ltd., Dr. J. G. Kane, Head, Oils and Fats Section, Department of Chemical Technology, University of Bombay, Dr. K. K. Dole, Professor of Chemistry, Fergusson College, Poona, Dr. J. S. Aggarwal, Head, Oils and Fats Section, National Chemical Laboratory of India, Poona, Dr. J. S. Badami, General Manager, Swastik Oil Mills Ltd., Bombay, Principal J. C. Bahl, of Siddharth College, Bombay, Dr. B. G. Gunde of Tata Oil Mills Co. Ltd., Bombay, Dr. G. S. Hattiangadi of Messrs. Hindustan Vanaspati Manufacturing Co. Ltd., Bombay and many others, who have served on our various Symposium and Exhibition Committees, and have taken a very active part in organising the Symposium and the Exhibition. I am sure but for their active help and co-operation both these gatherings would not have attained that measure of success as we witness at present. The Symposium and the Exhibition have this time attracted international attention to a considerable extent and we have received many interesting exhibits, samples, papers, etc., from some foreign countries. I feel that our labours for organising the Symposium and the Exhibition would be considered to be duly rewarded, if they would be our humble contribution towards the advancement of knowledge and development of research works, for which we have still to make considerable leeway and progress in this field. The oleagenous wealth of the country should also be considered as a gift of nature to our land and if I may say so, these natural resources, should be scientifically exploited and economically developed for the enrichment of our national economy.

We are having a very heavy programme and I would refrain from taking any more of your time. I would once again extent to you all a very cordial welcome to this gathering.

Now. I would request Shri K. D. Malaviya to inaugurate the Symposium and the Exhibition.

# PRESIDENTIAL ADDRESS OF MR. NAVAL H. TATA

at the

Symposium & Exhibition on Oils, Fats and Allied Products held under the auspices of the Oil Merchants' Chamber Ltd.

at Resham Bhavan, Bombay,

on 31st October and 1st November 1955.

I thank the organisers of the Symposium and of the Exhibition for inviting me to preside over the Symposium and at the inaugural ceremony of the Exhibition. I am grateful to the Chairman for the kind sentiments he has expressed about me. The Oil Merchants' Chamber deserves our congratulations for having organised the present Symposium in quick succession of another successful one only two years ago. The present Symposium carries with it an interesting and instructive Exhibition, which, I may say, is the first of its kind in this country.

2. I have no doubt that you have heard with rapt attention the inaugural address by Shri K. D. Malaviya, Minister for Natural Resources, Government of India. His thought provoking speech will, no doubt merit all the attention it deserves and I am sure the points raised by him will be carefully considered by all concerned.

3. Trade, Industry and Science are inextricably connected, and their progress is therefore, interdependent to a great extent. Advanced scientific research is a great contributing factor in the development of industry, which, in turn, lends prosperity to trade, resulting in increased industrialisation and greater production of goods and materials.

4. It is gratifying to note, judging from this distinguished gathering, that occasions like this are instrumental in bringing the representatives of trade, industry and science interested in the sphere of oil, fats and allied industries in closer contact with each other. Such contacts are invaluable in enriching the oils and fats economy of our country, apart from ensuring proper utilisation of our unfathomed oleaginous wealth of our country, which has not yet been exploited in the interests of our national economy.

5. As you are aware, India is one of the leading oilseeds producing countries in the world, and oilseeds, oils, etc. play important part in our national economy. With the increasing impetus given to the exports of vegetable oils in preference to oilseeds, the export of the former has assumed added importance in our export trade. For the growth and development of the vegetable oil trade of the country, it needs to be regulated on a more organised basis, which cannot be achieved without a country-wide uniform standard contract for major vegetable oils. Such all-India contract will go a long way in achieving

the above object. Though we are exporting a considerable quantity of vegetable oils, it is seldom that it is traded on our own national export contract terms. However, well received the other contract might be, I am strongly in favour, as an exporting nation, of having our own contract for export trade in vegetable oils. I understand that the Government of India are convening, sometime during the last week of November, a meeting at Bombay to consider the question of compulsory grading of vegetable oils for export. I do not, at this stage propose to discuss that issue which bristles with practical difficulties. I would leave that to be dealt with by the Delegates to the Conference in the hope that the authorities will, in consultation with the trade representatives, consider the question of evolving an export contract for our vegetable oils.

6. Our present day pattern of local as well as international trade requires long-range planning for the smooth functioning of the trade. Forward markets can be of great help to the producers, manufacturers as well as traders. The question of allowing forward trading in certain oils at certain places is, I believe, under active consideration by the authorities concerned. With the new crop movements just ahead, I feel it would be in the interest of all concerned that the Government should expedite their decision, so that in the impending busy season, the facilities of organised and genuine forward-trading in vegetable oils may be available to the trade.

7. There is another aspect of the problem to which I would like to draw the attention of the authorities. Of late, we have been exporting the major portion of our vegetable oils in bulk, and this is a move in the right direction. Our total export of vegetable oils have exceeded more than one lakh tons. It is very likely that, as a result of the increased production of oilseeds during the First Five-Year Plan and with similar emphasis for further increase in the Second Five-Year Plan, I envisage a further spurt in the export of our vegetable oils, earning valuable foreign exchange for our national economy. I feel that, in promoting our export trade in vegetable oils, adequate transport facilities over the Railways and a greater number of tankers in steamers would prove more helpful. I, therefore, feel that it should be the constant endeavour of Government as well as our national shipping companies to have more tankers of different sizes in our national fleet of merchant marine to provide further impetus to our export trade. This is no doubt a stupendous task, but I am sure, with the active help and co-operation of Government, we should right now concentrate on this matter and think of devising ways and means for providing additional number of tankers in our fleet for promoting bulk shipment of vegetable oils.

8. Maximum recovery of oil from oilseeds as well as from oilcake is one of the cardinal needs for the efficient and economic utilisation of our oilseeds resources. Despite acceptance of such basic thesis in all quarters, it is regrettable to note that the high proportion of residue oil content in different kinds

of oilcakes produced indicates that our extraction methods are far from satisfactory. In my opinion this matter deserves very high priority amongst the problems of crushing industry. It is true that solvent extraction process has come into vogue, but it is not as yet adopted on a very extensive scale, owing to various restrictions imposed on the use of this plant and the ban on the export of certain types of cake meal. It is, therefore, gratifying to note that, lately, certain relaxation in the export of solvent extracted cake has given some relief to exporters. However, it deserves more support and encouragement at the hands of the authorities, so that the solvent extraction may be increasingly resorted to in our country and thus build up our export trade in solvent extracted oilcake.

9. The Government of India have, after a lapse of about 15 years, recently allowed the export of oilcakes due to the comfortable supply position of the Chemical Fertilizers as well as the increased production of different oilcakes in our country. I feel that the time has come when we should not rest content with the export of more oilcakes only as such. We should make a through study of the technique of their use in the importing countries and we should aim at exporting composite cattlefeed and manure which are the ultimate forms in which our oilcakes are used after certain processing or mixing in the importing countries. Bigger crushing units can also evolve their particular brands of such composite cattle feed, which might be having the requisite protein content and other ingredients, which would enhance their utility either as cattle feed or manure and export the same to foreign countries. Our research institutes can also prove helpful to the crushing industry in this field by making a detailed scientific and technical study of this question and help them in evolving different type of composite cattle feed from different varieties of oilcakes.

10. Our country abounds in a number of minor or less known oilseeds and oil-bearing materials, which are not being commercially exploited to the extent we should. From the exhibits displayed in the Exhibition as well as the Papers on Less Known Oilseeds and Oils you will notice that these oleaginous orphans, as I would put them, are capable of augmenting the supplies of vegetable oils for varied uses and also for yielding different products and by-products therefrom as in the case of our principal oilseeds, provided such obscure seeds are developed on a scientific and economic basis. It is true that the Indian Central Oilseeds Committee has made a beginning in this field by conducting a survey of minor oilseeds in different States of our country, but I feel that the pace of its progress is not satisfactory. Unless the Oilseed Committee plans and arranges to recover about 8 to 10 lakh tons of such minor oilseeds and other oil bearing material within the next five years and put them to economic uses, I am afraid it would give an impression that we are not so determined to make the best possible use of our latent oleaginous wealth. No wonder that many people do not yet know that oil can be extracted from tobacco seed and rice bran. There may be many more seeds,

the existence of which may not be known to the commercial community, nay, even to those interested in oils, fats, etc. I understand that such rare oilseeds and oils are subjected to research at different research institutes and efforts should be intensified with utmost vigour to develop various possible uses and products as well as bye-products therefrom and enable their commercial utilisation on a general scale. This is a field in which we cannot rest on our oars. Ceaseless efforts and constant endeavours are continually needed.

11. As you all might be aware, Government have appointed the Oil Crushing Industry Inquiry Committee to go into the entire question of the development of crushing industry. Shri Ratilal M. Gandhi, the Chairman of the Reception Committee and President of the Chamber, is one of the Members of this Committee. The Committee is, I understand, busy in examining this question in all its aspects, and we can expect their report at an early date. I have no desire to enter into any controversy at this stage, but I hope, looking to the conditions of the oil milling industry, Government will consider the whole matter in the best interest of the Crushing Industry as a whole and devise ways and means which would ensure the development of this industry which has suffered to a great extent so far.

12. I take this opportunity of voicing a feeling that the pace of scientific research in the field of oils, etc., has not sufficiently progressed and achieved solid result due to the fact that there is no Central Research Institute which may initiate, guide as well as co-ordinate different branches of research work in this sphere. Our Central Organisation, along with other all-India Organisations devoted to vanaspati industry, soap industry and oil technology, had, therefore, addressed last year a joint memorandum to the Government of India urging the establishment of a national laboratory for oils, fats and allied products at an early date. The Minister for Natural Resources is, fortunately, with us on this occasion, and I am sure he would consider this suggestion sympathetically. I understand that the Indian Central Oilseeds Committee is also moving in the matter of having a Central Oil Technological Research Institute under its auspices. I am sure a National Laboratory or a Central Institute, by whatever name we may choose to call it, will go a long way in providing impetus to the cause of advanced research in the field of oils, fats and allied products. We would make the best possible use of the scattered talent, whether commercial, industrial or technical, devoted to oils and their products for the betterment of our economy and the progress of our country.

13. We have before us a very interesting and educative programme, and I would not like to take any more of your time as interesting papers on oil technology will follow as soon as I close. I congratulate the authors who have submitted Papers for their painstaking efforts and the variety of interesting subjcts they have touched. I once again thank the organisers of this Symposium and Exhibition for inviting me to preside over this function and I thank you for having given me a patient hearing.

# INTRODUCTION

Symposia on selected topics, when held periodically, permit one to obtain an overall picture of the achievements in that field during a specified time. They indicate the trend of work, highlight the emphasis given to certain aspects, and reveal the gaps. Therefore the groups that assemble on such occasions should avail of the opportunity for an unbiased and critical examination of each other's work.

The fifty-four papers that have been presented at the Fourth Symposium on Oils, Fats and Allied Products, deal with a variety of topics. The field of fatty oils is so vast and diverse that one cannot expect to have the entire field to be covered by papers incorporating researches done in a limited period of time. The papers received have been classified broadly into the following eight groups.:—

1. **Oilseeds & Oils.**
2. **Extraction.**
3. **Refining.**
4. **Food & Nutrition.**
5. **Chemistry & Analysis.**
6. **Soaps & Detergents.**
7. **Surface coatings.**
8. **General.**

India is the third largest producer of oils and oilseeds in the world and yet, on account of the ever-increasing human population, the rising standard of living and the ever increasing new and wider uses for oils and fats, a shortage of both edible and non-edible oils is likely to occur in the not-too-distant future. There are several remedies to cure this problem, the most outstanding one which has received attention from scientific workers during the last ten years being the exploitation of the minor or less-known oilseeds of which India has a great variety. The utilization of neem seed which is widely available is an illustration of this effort. In the vast forests and along the roadside, several seeds ( viz. pisa, khakan, gokhru, undi, karanja, manor, kamala, dhupa, malkanguni, etc. ) are available. However, their ultimate benefit to the consumers in practice is beset with numerous difficulties, such as, cultivation, manner of collection, cost of collection, storage, extraction, refining. Exploitation of these seeds is really a test of our co-operative effort because one single agency like that of a research chemist can achieve very little except showing the properties of the particular oil and its potentialities. The agriculturist, the forestor, the villager, the tradesman, the various Government agencies, the scientist, the technologist, all must work together to bring this problem to a successful end. Several papers deal with this aspect with particular reference to neem oil.

Cottonseed has been the most neglected oilseed in this country. In contrast, a highly developed cottonseed industry is thriving in U.S.A. Therefore, it is appropriate that there are papers which deal with the storage of the seed and oil, processing of the seed, crushing of the seed etc. It is emphasised that the utilization of cottonseed gives by-products like lint, hulls and cake, which are of commercial importance.

In our search for newer sources of fatty oils, we come across some by-products which normally go to waste. Rice bran is such a material which is available in plenty. The potentialities of this bran, the production of the oil and the relevant economics have now received the attention of some workers.

Along with the above efforts, one direct method of increasing our oilseed wealth is to increase the yield of the seeds per acre. Important work in this direction, has been reported from several agricultural stations. Improved strains of different seeds which include groundnut, sesame, safflower, castor nigerseed and linseed, have been developed, and their scientific cultivation and harvesting have led to increased yields. In addition, the cultural, varieta and manurial aspects, prevention of diseases and eradication of pests have also received attention. Valuable information has been made available especially on groundnut and copra.

When the seeds are processed by various methods for oil extraction, different operations must be carried out under controlled conditions so as to ge the optimum yields. Papers on crushing, cooking and solvent extraction give considerable information, the value of which has increased because it has come from persons within industry. Solvent extraction is new to this country and therefore papers which discuss the problems of this industry are a very timely contribution, dealing as they do with the use and economics of alcohol and petroleum solvents for extraction.

In the field of refining, it is of interest to note that neem and cottonseed oils have again become the subject of a few papers. The oil refining industry uses large amounts of activated earths and carbons. We still depend on foreign suppliers for good quality earths and carbons. From the research reports contained in some papers, it is gratifying to know that a study of indigenous raw materials in this respect is being actively pursued at many research stations.

In the realm of food and nutrition, the fortification of vanaspati with vitamin A, the use of natural anti-oxidants for edible fats, the nutritive value of nigerseed oil, and the addition of monoglycerides to food products, are some of the subjects, the information on which will be found quite useful.

In the field of soaps and detergents, attention has been directed to the rapid strides that have been made by synthetic non-soapy detergents. Another paper shows how good-quality soaps can be made entirely from non-edible oils.

Very important subjects have been dealt with in connection with the utilisation of oil for surface protection. Jangali badam, kamala, and gokhru yield oils that have good drying properties. Upgrading of linseed oils by various methods, preparation of alkyd resins, and removal of "after-tack" in dehydrated castor oil have been discussed in several research papers.

Papers on the fundamental and chemical aspects of oils include those giving the properties and fatty acid compositions of tung oil, kavathi oil and hydrogenated fats. The new technics of separation by urea adducts and low temperature crystallisation have been employed in investigating the fatty acid composition of several oils. Preparation of long-chain hydroxy and carboxyl acids from fats has been studied in one paper. Interesting studies on the production of fats by micro-organisms have been reported in two papers. Marketing of vegetable oils gives a general finishing touch to the long list of papers contributed by several workers in different parts of the country.

On the whole, the research work reported indicates an awareness on the part of workers of the present needs of the country. It is hoped that such symposia will give an impetus to our research work, both fundamental and applied.

The papers that were presented at the Symposium are given in an unabridged form in the following pages together with a brief account of the Exhibition.

# CORRECTIONS

Please read as under :

(i) **Page No. 70.**

**V. M. Chavan,**

Retired Deputy Director of Agriculture (Crop Research) Bombay State, Poona 5.

**P. Y. Shendge,**

Senior Technical Assistant to the Dy. Director of Agriculture (Crop Research) Bombay State, Poona 5.

(ii) **Page No. 189.**

Fig. IV

Fluorescence Spectra of Karanja Oil.

⊙ – – ⊙ 0.076 g/1 of Karanja Oil in alcohol.

△ – – △ 0.096 g/1 of Karanja Oil in Petrol.

# OILSEEDS
# &
# OILS

# ECONOMIC UTILISATION OF LESS KNOWN OILSEEDS OF INDIA

J. S. Aggarwal.

National Chemical Laboratory of India, Poona.

**Many less known and hitherto neglected oilseeds are found in different parts of India. The oils extracted from them are usually of dark colour, possess disagreeable odour and contain sufficient quantities of non-glyceridic constituents. They must either be subjected to lengthy refining processes or specially treated for use in various industries, and so they should be available at sufficiently less prices than the oils that are at present being used. To effect this reduction in prices of these oils, the seeds should be collected at the lowest possible cost. Their collection through village uplift boards and industries' organisations is suggested.**

India is one of the major oilseed producing countries of the world. Her production of principal oilseeds consisting of groundnuts, rape, mustard, sesame, linseed, cottonseed, castor and mahua annually amounts to nearly 70,00,000 tons. Besides the above, niger and safflower seeds are also grown in some localities. Many of these oilseeds are obtained as agricultural crops and others are collected from trees reared in groves in certain localities. Their collection, therefore, is quite easy and is always carried out on economic lines. But there are other oilseeds the plants of which lie scattered at different places and there are no proper and organised methods adopted for their collection. In some cases, they can be collected in sufficiently large quantities and their oils can form raw materials for many industries. It is expected that the proper collection of such oilseeds will form an important subject of development in the Second Five-Year Plan. Although the oil contents of many of these seeds are in the same order as groundnuts, mustard and linseed, their oils are generally dark in colour and in certain cases possess peculiar disagreeable odours. They have, therefore, to be given specific refining and deodourisation treatments before they can be put to various industrial uses. A number of such oilseeds was discussed in the paper entitled "Some less known oilseeds of India" presented by me in the symposium held in February, 1953, under the auspices of the Oil Merchants' Chamber Ltd. at Bombay. In order to make the subject more clear and complete, I am mentioning a few of them here again giving a summary of upto-date work that has been done on the utilization of their oils.

Neem, **Melia indica,** trees are found generally on the road sides in nearly all the parts of India and are also grown elsewhere for the excellent shade they give. Although no reliable data are available in regard to the production of neem seeds, according to the Indian Central Oilseeds Committee, in U. P. alone, the number of avenue trees on roads only is estimated to be over 3 million which would yield about 4.5 million maunds of seeds containing about 45 per cent oil. The report states "most of the neem fruit is, however, not collected but allowed to go waste. At some places, some of the fruits are collected and treated to produce the seed from which the oil is obtained by pressing either in ghannies or in hand screw presses. But the collection and pressing of the seed is not yet practised on any scale commensurate with the huge quantities of fruits produced". Apart from the very limited uses of the oil for illumination, in low grade soap in very small quantities and the scanty requirements of the practitioners of the indigenous system of medicine there seems to be no regular demand of the oil. The major draw-backs in the large scale use of the oil are : (1) proper method of treatment of the neem fruit to get rid of its outer skin and the mucilagenous matter to produce good dry seed is yet not developed, (2) the oil has obnoxious smell, bitter taste and dark colour, the removal of which has resisted the usual alkali and acid methods of refining of the oils. Work is in progress at the Hartcourt Butler Technological Institute, Kanpur in the first direction and an alcoholic method of refining the crude neem oil has been developed at the National Chemical Laboratory, Poona as a result of which the treated oil gives a very pale coloured soap and it can be hydrogenated to produce fat for hard soaps and for the manufacture of commercial stearin. Pilot plant work to find out the cost of the process of refining of the oil is now in progress. It has also been found that if soap is prepared from neem oil alone by boiling process and salted out twice or thrice a sufficiently pale coloured soap of much less smell is obtained. This soap can be further mixed with other oils to be used for the preparation of final soap.

Nahor or nageswar seed is obtained from the tree **Mesua ferrea Linn** which grows wild in Bengal, Assam, Burma and South India. The nuts yield 60-77 per cent of a reddish brown oil but the soap prepared from it stains the cloth brown. The oil can be refined to a pale colour either by a two stage alkali refining process or extraction of its colouring matter and resinous impurities with alcohol. The soap from such a refined oil does not colour the cloth. The very dark bluish black colour of **calophyllum inophyllum** or undi oil is due to the presence of about 30 per cent of resinous impurities in it. By similar refining processes as above, the oil can be freed from these impurities to a very pale coloured oil. **Calophyllum inophyllum** seeds are available in large quantities in Bombay State, South India and Orissa is known by various names as polang, punnal, undi, domba and pinnai. The refined oil is very good for soap manufacture. Karanja or **Pangomia glabra** seed is available in large quantities in Southern India and contains about 35 per cent of yellowish brown oil of acrid odour. As with neem oil, this oil can best be refined by alcoholic extraction.

Of special interest is the yellowish green fat obtained from pilu seeds botanically called **Salvadora oleoides.** The pilu tree or shrub is a native of the arid tracts of Sind, Punjab, North Gujerat and Rajputana. The seeds contain about 40-43 per cent of fat commonly known as khakan fat which is very similar to coconut oil in its fatty acid composition. Sufficiently large quantities of pilu seeds are available from these areas and if proper and scientific use is made, it can relieve much of the coconut oil from the soap manufacture. It has been found that if the soap is salted out twice or thrice much of the colour of the fat is removed.

There are many other oilseeds which if properly collected will give useful oils for industries like soap and detergents, paints and varnishes. The work carried out and also in progress at the National Chemical Laboratory, Poona and Forest Research Institute, Dehra Dun gives bright prospects for the utilization of kamala seed oil in paints and varnishes. Tobacco seeds, which are only collected to a limited extent, can also form a source of satisfactory paint oil. Work is at present in progress at the National Chemical Laboratory, Poona on the oil from the seeds of **stercula foetida** (Hindi, Jangli Badam) which polymerises very rapidly to a gel when heated at about 200°C. One point, however, deserves very careful consideration for the economic utilization of the oils of these less known and hitherto neglected oilseeds in the industry. As shown above the oils from most of these oilseeds are dark in colour and possess disagreeable odour and in certain cases contain sufficient quantities of non-glyceridic constituents as resins and colouring matter. Special and lengthy treatments for their refining or for their utilization in the manufacture of various products are necessary. The fruits of some of them are to be specially treated so that the seeds can be easily removed from them. The burs of gokhru (**xanthium strumarium**) are to be soaked in dilute sulphuric acid and then sun-dried so that they become friable for the easy removal of the seeds. Kamala seeds and particularly karanja seeds are to be removed from their pods by manual labour only. Similarly special treatment to the neem fruit is necessary. All these special processes entail a good deal of expenditure. In order therefore that these seeds-oils can be economically available for use in Industry they must be sufficiently cheaper than well known oils as linseed, groundnut and coconut oils of which they will form substitutes. As far as possible they must also be available in sufficient quantities. Low cost of the raw material and its availability in reasonably sufficient quantity are the two chief considerations which can only attract the industry to utilize it. As these less known oilseeds are of natural growth, their oils will only be cheap if they are collected at very low costs. This cannot be done by forest or other State Departments. Even private individuals and special contractors may not be able to do the task at reasonable rates in view of the fact that the trees are usually scattered over different areas at distant places. There is every possibility that this can be economically accomplished by various village uplift boards and industries' associations. These organisations are closely connected with the villagers and the conditions prevailing there. They can get these less known oilseeds collected at the right time through the women and children of these places at a very low cost. Whereas it will not be a very laborious task for these persons they will be sure of the ready payment of whatever they collect if taken to the nearest office of the Village Uplift or industries' association. In this way, there are chances that almost the entire production of such seeds may be collected from the particular areas. When one type of seeds are all collected they can be got pressed either in a local ghani or sent to crushing mill or a solvent extraction plant as considered necessary. This method will provide employment to the villagers and also will be helpful in the collection of these materials at a reasonably low cost. It may be pointed out that if at certain times the other development work for cottage industries is retarded for the collection of such less known oilseeds, herbs and other raw materials that are grown in those areas, it will not be harmful in the rural uplift work.

Besides the less known oilseeds that are available in sufficient quantities, there are others which can only be collected in very limited amounts. The village industries' boards and uplift associations can get them collected and oilseeds of similar nature can be mixed. The mixed seed oil can be used in various industries. For examples the seeds of lauric acid rich oils as **Actionodaphne hookeri, Actionodaphne angustifolia, Cinnamonium camphora, Laurus nobiles, Litsea chinensis, Litsea citrata** and **Litsea zeylanica** all of which are grown in Bombay State, can be collected together and the mixed seed fat will be very useful in soap manufacture as a substitute for coconut oil. Similarly, schemes for the collection of the seeds of some vegetables and fruits such as pumpkin, melon and water melon may also be possible. These seeds contain sufficiently large quantities of oils and they can be expressed either as such or as their mixture. The seed oil can be used for edible purposes, soap making and other industrial purposes. Various village organizations can get information about these oilseeds and their oils, such as refining of the oils, their utility, etc. from various central and state scientific laboratories, chemical and technological departments of various Universities etc. For information it may be mentioned that extensive work is at progress at the Department of Chemical Technology, Bombay University on the various methods of refining of these oils. The National Chemical Laboratory, Poona has also been engaged on similar work and in finding various uses of some of these less known and hitherto neglected seed oils.

This method of collection of various less known oilseeds and even other herbs etc. through village uplift and industrial organizations besides providing work, employment and financial assistance to many of the villagers may give them an incentive to raise the plantations of some of them in order to increase their yields.

# STORAGE OF COTTONSEED

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**With the rapid development of cottonseed processing industry in India storage of cottonseed on large scale assumes vital importance. The need for extensive survey and studies on storage behaviour cannot be over emphasised.**

**A critical survey of the existing methods in United States of America and the present practices at important cotton centres of the State is made.**

**Results of the work, undertaken at the Central Laboratories, are also presented.**

The development of cottonseed processing industry is of recent origin and is still in the initial stages. One of the vital aspects of cottonseed processing is the storage problem of the seed prior to its treatment and utilization. The seed hitherto has been used either for cattle feeding or for sowing purposes and the problem of storage on large scale did not arise. But when a large scale processing industry is established the bulk storage of seed, sufficient to last till next session's need is available, is almost a necessity.

The storage of cottonseed in bulk is a new experience for India. Though great deal of work on this subject has been carried out in the U. S. A. on American seed, their experience and results though extremely useful may not be capable of duplication with Indian seed. As the varieties of the seed, their composition, the climatic condition and the quantities of seed handled are different from those of American seed, information and data regarding the behaviour of the seed on storage under Indian conditions has to be collected. This may help to modify the American practice to suit conditions prevailing in India.

Stored cottonseed undergoes deterioration due to the biochemical changes taking place in the seed. Cottonseed behaves in a somewhat different way than other oil bearing seeds like groundnut, castor etc., due to the residual lint adhering to the seed and the complex pigment system in the seed. The heat produced during the biochemical changes in the seed is not dissipated due to the insulating effect of the linters. This results in further deterioration and there is an increase in the F. F. A., loss of viability, and a darkening of the colour of seed and of refined oil made from same. The increased refining loss due to increased F. F. A. and poorer quality of products, results in considerable economic loss to the oil mill processing same.

The major contributing factors to these changes are (i) moisture (ii) temperature (iii) maturity (iv) presence of foreign matter (v) Disintegration of meats (vi) Atmospheric conditions during harvesting and subsequent storage (vii) Initial condition of the seed (viii) Micro-organisms etc. The effect of these contributing factors on the biochemical changes has been extensively studied.

In American practice precautions are taken right from the moment the boll bursts open on the stalk. The cotton bolls are picked up as rapidly as possible with a minimum of exposure to wet weather.

At the gins the seed as it comes in from the fields is not allowed to be stored with a moisture level above 10—11 per cent. It is very common to instal cotton driers at the gins. Drying of seed cotton before ginning at 160—220°F is reported to retard the formation of free fatty acids in stored seed. The drying of seed cotton reduces the danger of development of heat in the seed pile.

At the cotton mills the seed is received in trucks or by rail from about 10—100 miles territory. This seed is likely to be different in quality and it is very essential that a selective storage of the seed is done. For the proper storage of seeds, the important considerations are per cent moisture and per cent F. F. A. in the oil. It is not practicable to analyse the seed while the unloading is being done. It is, therefore, necessary to rely on previous 'shipper', analysis which is strictly done according to the official recognised methods. The seed is dried in cottonseed driers at 220°F, if necessary, to bring the moisture level to 10—11% before storing the seed.

There are two types of seed storage units in common use in the States. (1) seed houses (2) Silos.

1. **Seed houses**: The Muskoges type with capacity 100—1000 tons are very common and are about 90—120 ft. wide and 10—200 ft. long. The slope of the roof is 45°. Lateral seed ventilating ducts, located every 8 feet, extend along the floor of the house. These may be shut off from the central pipe, which is connected to a single or double 40 or 60" fan. This permits cooling of any warm centres which may have developed.

2. **Silos**: These are generally built of steel and are about 70 ft. in dia. and 60 ft. high, ranging in capacity from 1,000—4,500 tons.

The seeds are flown to the top of the silo and are spread by a distributor. This gives better mixing, uniform filling and some air cooling which reduces the moisture content. The silo has a false bottom which permits uniform air ventilation.

Besides drying, air cooling and selective storage of the seeds, chemical inhibition is also being attempted. It is not yet a commercial success.

As against the above systematic and scientific methods practised in the States the methods in India are very crude and unscientific. As far as we are aware no mill or gin ever does any analysis of the seed. Therefore there is no control over the quality of the seed.

At the gins the seed cotton arrives in bullock carts or on camel back and is heaped in the open on loose ground. The seeds are also stored in the open or in shaded godowns in heaps or piles of gunny bags. The period of storage extends from 1-6 months or more depending upon the market conditions.

A number of ginning centres and oilmills crushing cotton seed in Hyderabad State were visited as a part of the investigation. It was found that most of them reported a colour change in the seed and that insect attack reduced stocks by about 25% in about a year's time. At one place (Adilabad) excessive heating of the seed appears to have resulted actually in an outbreak of fire.

The seed is sent to the oil mills mostly to Hyderabad by truck or train in gunny bags. Usually it goes via the wholesale agents who retain the seed in their own or hired godowns for a period of 1—6 weeks or more. At the mills the seed is piled up in gunny bags without any air cooling arrangements. The cottonseed crushers in Hyderabad and possibly elsewhere also in India are not fully aware of the implications of faulty storage of seed. The crushing is not done throughout the year but only when the oil prices go up. The processing is often limited to only delinting of the seed, the delinted seed being then stored for sale as cattle food, or for crushing for oil at a later date. Systematic crushing of seed, on a whole time basis instead of sporadic attempts coupled with better storage of the seed and its products is very necessary if the industry is to prosper in this country.

Work on the storage studies on the cottonseed and oil was started at the Central Laboratories with a view to collect data on the behaviour of cottonseed stored under different conditions of humidity and temperature. A scheme on storage studies, financed by the Indian Central Oilseeds Committee is now in progress.

A local variety of cottonseed—American Parbhani was studied, under three different conditions of temperature and humidity, for changes in moisture, F.F.A., Peroxide value and colour in oil, and viability. It was observed that :

1. The moisture increases rapidly, during the first 10 days and then remains constant if the humidity is constant.

2. The increase in F.F.A. is proportional to the equilibrium moisture content; e.g., at 33°C and 80 per cent relative humidity (R.H.) when the equilibrium moisture content of the seed was 13.4 per cent the seed had increased in F.F.A. from 3 to 12.8% in 50 days. At 33°C and 65 per cent R.H. the

F.F.A. had changed from 2 to 4% in about 90 days when the equilibrium moisture content of the seed was 9.1 per cent.

3. Temperature favours the development of F.F.A. At 40°C and 86 per cent R.H. the change in F.F.A. was from 1.1 to 15.8 per cent in 35 days, while at 33° and 80 per cent R.H. it had changed from 3 to 12.8% in 50 days.

4. The viability is decreased when the seed is stored under conditions where development of F.F.A. is favoured.

5. The Peroxide value of the oil from the stored seed does not alter to any appreciable extent and remains below 5 units.

6. The colour of the oil extracted from the stored seed is variable and could not be correlated with storage conditions.

7. The meats became very dark during 1 to 1½ months storage at moisture level of about 13 per cent and above.

As against this the seed when stored in gunny bags on cement floor under room conditions increased in F.F.A. from 1.1 to 4% during 8 months period. The moisture content of seed changed from 6.4 to 8.5 per cent. During this period more than 25 per cent of the seed was infected with insects. The viability of the uninfected seed was 100 per cent. But there was caking of the seed in lumps.

Work on different varieties from Bombay, Madras and Hyderabad States is now in progress. The effect of bulk storage of seed is also being studied.

# GROUNDNUT—"A WONDER NUT"

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**The importance of groundnut in our national economy is discussed and the establishment of an organization like the Indian Central Coconut Committee to promote the cultivation and utilization of groundnut has been advocated.**

Soyabean is called the Wonder bean in America due to its multifarious uses. In India the coconut tree is called "Kalpa Vriksha" because every part of the plant finds some use or other. The groundnut plays perhaps a much more important role and it is truly our "Wonder nut" the mainstay of our oil and allied industries.

The groundnut had very humble beginnings. Originating in South America from the area drained by the Parana river it spread eastward to Africa by the agency of the Portuguese slave traders who used it as rations on their ships. The slave trade brought it back west-ward to North America. From North America it spread to Peru. It travelled with Magellon in 1519 to the Far East and then to India and other parts of Asia. (1).

From this small beginning its cultivation has increased enormously and it now ranks among the three most important oilseeds of the world in terms of tonnage produced. The world production of groundnut in 1953-54 has been computed as 10,889,000 tons compared with cottonseed 15,121,000 and soyabean 17,800,000 tons (2).

The groundnut plant is reported to have been introduced in India in the 16th Century. Its cultivation has extended at a phenomenal rate in recent years and to-day India is the largest producer of groundnut accounting for more than one-third of the world production of the same. It is also the most important oilseeds crop in India as can be seen from the table below giving the production of the major oilseeds in India :—(3)

| **Name of the seed.** | **Production in 1953-54.**<br>Tons. |
|---|---|
| (1) Groundnut | 3,772,000 |
| (2) Cottonseed | 1,377,000 |
| (3) Rape and Mustard | 825,000 |
| (4) Sesame | 531,000 |
| (5) Linseed | 354,000 |
| (6) Copra | 185,000 |
| (7) Castor | 107,000 |
| Total : | 7,151,000 |

Groundnut has been a boon to India in many ways. Being a leguminous crop it has got the capacity to fix atmospheric nitrogen and thus enhance the fertility of the soil. The vines left after the removal of ripe groundnut pods serve as an excellent fodder to cattle. The husk serves as a useful fuel and quite recently it has served as a raw material for experiments in the manufacture of activated carbon.

The groundnuts are a cheap and rich source of fat, protein, Vitamin $B_1$, Vitamin $B_2$, Nicotinic acid and Vitamin E. (4).

The nuts are eaten either raw or after roasting. In the United States Peanut butter prepared from the nuts has become an article of daily diet. It is prepared by grinding roasted kernels after removing the seed coat. The mass is mixed with 1-4% salt and packked in hermetically sealed tins or jars.

Groundnut oil is the most important product obtained from groundnuts. The high yield of oil coupled with the ease in processing has made it a favourite among oil millers. The oil because of its desirable characteristics is much in demand for the preparation of hydrogenated fats used for edible and soap making purposes.

The groundnut cake is one of the cheapest oil cakes, rich in protein and it finds application as a cattle feed and as manure. Groundnut flour is made from selected grade of groundnut cake. Groundnut protein has been prepared from high grade groundnut cake of low oil content of about 1.0 to 1.5%. The protein is useful as an adhesive in the plywood industry. Ardil (5) a semi synthetic fibre resembling wool is made from specially prepared groundnut protein.

Plastics from groundnut cake and saw dust is a new development (6) in the field. Useful molding compositions have been prepared in our laboratories by auto-claving a mixture of groundnut cake and saw dust. Though the work is still in the development stage, this new type of plastic holds great promise since it is made from inexpensive materials like groundnut and saw dust.

The production of vegetable milk and curds from groundnut requires special mention. Milk and curds from groundnut practically indistinguishable from that of cow or buffalo are now made at a factory at Trichur. Travancore-Cochin largely as a result of work done by the Central Food Technological Research Institute of Mysore. (7) There is scope for such factories in almost all towns in India. Popularisation of vegetable milk will help in the diversion of pure milk for the consumption of children and expectant mothers who require it very badly.

Inspite of the large production of oilseeds the people of India are considered underfed as regards oils and fats.

The Panel of the oil and Soap Industries of the Government of India (1947) estimated that the per capita consumption of edible oil in India was 0.35 oz. per day and later in 1951 the estimate was raised to 1/2 oz. per day while the minimum per capita consumption should be at least 2 oz. per day as recommended by the Nutrition Advisory Committee (3). Even a small increase of oil consumption from 1/2 oz. to 1 oz. calls for a two fold increase in the production of our oilseeds and the problem before us now is how we can achieve our target.

One suggestion put forward is that we should take steps for the intensive exploitation of our lesser known oilseeds growing wild in the forests. But there are practical difficulties in the way. The other alternative is to increase the production of the known oilseeds. The groundnut offers itself as an oilseed "par excellence" for more widespread cultivation.

A glance at the groundnut map of India will indicate that the cultivation is now centralized in a few districts of Madras, Bombay and Hyderabad. The research work done at the various Government farms in the country has clearly shown that the groundnut can be grown in other parts of India as well. So steps must be taken to spread its cultivation to areas where it is unknown to-day.

Now the question arises as to who will do this job of increasing the acreage in groundnut cultivation. The exporter in oil and oilseeds is anxious to have a plentiful supply of groundnuts and no government restrictions so that competition in export markets can be successfully met. The oil miller wants groundnuts the grist for his mill. The Vanaspati Manufacturer is happy only when there is plentiful supply of groundnut oil. The soap manufacturers want a cheap and plentiful supply of groundnut oil for the manufacture of soaps. The general public wants a plentiful supply of groundnut oil for direct consumption and also to serve as a check on the cost of the other oils used for consumption. Under these conditions the Government alone through the medium of a duly constituted body or committee will have the resources to tackle the important problems of increasing the cultivation of oilseeds in general and groundnut in particular.

The interests of oilseeds is now looked after by the Indian Central Oilseeds Committee. The need for a separate Committee to look after the interests of important individual oilseeds has been recognised in the past so that undivided attention can be given to individual oilseeds and the Indian Central Coconut Committee has been formed with this main objective. Those of us who are following the activities of this Committee by reading their journal will readily agree that a vast amount of useful work is done in the direction of coconut cultivation and utilisation. Similarly if there is a separate Committee for Groundnut also, it will be able to pay undivided attention to the furtherance of groundnut cultivation, utilization and trade.

We hope that our suggestion will meet with your approval and we request the Oil Merchants' Chamber to consider our proposal of having a separate Committee for Groundnut and make suitable representations to the Government.

Finally we thank M/s. Tata Oil Mills Co., Ltd. for permitting us to read this paper.

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# GROUNDNUT IN MYSORE

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**Cultural, varietal and manurial aspects of the crop are briefly dealt with. Pests and diseases along with their control measures are indicated. The part the crop is expected to play in Second Five-Year Plan is analysed. Measures to achieve the target of production set are detailed.**

Excluding U.S.S.R., Groundnuts are raised on an area of around 28 million acres in the world. Global production amounts to 10.9 million tons of nuts in shell. India has 12.6 million acres under this crop with a production of 3.8 million tons. The share of the Indian Union amounts to 45 per cent of the area, and 35 per cent of the production in the world. The area in Mysore is 5.33 lakhs of acres and production 1.2 lakhs of tons or over 4 per cent of the area, and 3 per cent of the production of the Union. The total area under all oilseed crops in Mysore is 7.2 lakhs of acres and production 1.5 lakhs of tons. This excludes the area under Coconuts which is principally an edible commodity. The share of the Groundnut crop thus amounts to 74 per cent of the area, and 80 per cent of the production of all oilseeds in the State. The First Five-Year Plan has set a target of 1,79.000 tons of all oilseeds, to be achieved by the end of 1955-56 season. In Second Five Year Plan this has been increased to 2,05,000 tons, to be achieved by the close of 1960-61 season.

It is obvious that in concerted measures undertaken to increase the total production of oilseeds in Mysore, major attention has to be devoted to Groundnut. The policy laid down by the plans for increasing the production of oilseeds, has always been by intensive cultivation. The measures recommended to be adopted are:

1. Multiplication on a sufficiently large scale of seeds of higher yielding varieties already evolved and distribution of these on planned basis so that the entire acreage under oilseeds may be covered by improved varieties.
2. Adoption of optimum seed rate and proper spacing by the cultivators.
3. Utilisation of manures wherever necessary.
4. Controlling of pests and diseases.

5. Introduction of crop competition schemes.

H.G.1 and H.G.3 are improved varieties evolved in Mysore. H.G.1 was one of the earliest varieties evolved in India. Distribution of it commenced as early as in 1920, and it occupied several thousand acres in the State. In addition, it also spread into Hyderabad and Madras, being known in the latter State as A.H.45. Apart from H.G.1, and H.G.3, some quantities of Sugatur a variant of Mauritius, Virginia, and Big Japan were released for cultivation in earlier years. These were all of spreading habit. In recent times, large quantities of Spanish and Small Japan have been regularly supplied to cultivators from several experimental farms. Issues of such seed, normally cover an area of 25-30 thousand acres. Recent work partially financed by the Indian Council of Agricultural Research and later by the Indian Central Oilseeds Committee has demonstrated the high yield and desirable qualities of the following varieties:

| Variety | Habit | Duration in Months | Yield pods lb./acre | Shelling | No. of seeds per Kg. | Oil % | Colour of seed |
|---|---|---|---|---|---|---|---|
| T.M.V. 3 | Spreading | 5 | 624 | 73 | 2575 | 49 | Rose |
| H.G. 7 | " | 4½ | 547 | 74 | 2908 | 50 | " |
| T.M.V. 1 (Control) | " | 4¾ | 500 | 72 | 2564 | 50 | " |
| H.G. 8 | Bunch | 4 | 553 | 79 | 2834 | 50 | Red |
| H.G. 9 | " | 4 | 539 | 78 | 3068 | 49 | Rose |
| Spanish (Control) | " | 4 | 441 | 74 | 3537 | 48 | " |
| H.G. 10 | " | 4¾ | 887 | 74 | 1909 | 49 | " |
| H.G. 1 | " | 4¾ | 674 | 72 | 2366 | 49 | " |

(T.M.V.1 and T.M.V.3 are improved varieties of Madras. H.G.9 has been tentatively retained on the approved list to replace H.G.8 in case the trade does not approve the red coloured kernels).

A seed distribution scheme sponsored by the Oilseeds Committee, has just commenced work. H.G.7, H.G.8 and H.G.10 are being multiplied under this Scheme. By the end of Second Five Year Plan, adequate seed to cover 27,000 acres is anticipated to be produced.

The normal seed rate usually employed is 100 lb. per acre of pods. This generally results in a seed rate of 70-72 lb. in the case of early bunch varieties, and 68-70 lb. for spreading ones. The spacing adopted is 4-6 inches between plants and 10-12 inches between rows. Where seed is of good quality 50 lb. would prove ample. This rate is usually employed in parts of the State, where rows are spaced 18 inches apart Experiments have proved that a spacing of 6-9 inches either way, results in maximum yields. Very close spacing hinders both weeding and intercultivation, except in very early stages.

Other measures to be adopted are the use of quality seed, early and clean weeding, and maintenance of a loose bunch to make it easy for the pegs to enter the soil and later develop into pods. Hand shelled seed always gives a more uniform stand and heavier yield than seed from decorticators. Shell just before sowing, dry the seeds a little and sow immediately. Kernels with broken skin give poor germination. Presoaking if tried, should avoid damage to seed coats. It is very important to sow as early in the season as possible, delay lowers the yield.

Manure is more often applied to the rotation crops than to Groundnut. When applied to groundnut, resulting increased yield just miss being significant. Organic manure has been observed to improve the drought resistance of the crop. N. P. K. either alone or in different combinations have resulted in significant increases of yield. The behaviour of N. was erratic and often of no economic value. P and K have proved beneficial, especially in association with organic manure. In some parts of the State, fertilisers at the rate of 1 cwt. of ammonium sulphate and 1 of super phosphate per acre, are regularly applied. Response to lime in combination with super phosphate has been encouraging.

The mining caterpillar **Stomopteryx nerteria** or sural is a major pest. Gammexane mixed with wood ash should be dusted to control the pest and save the crop. Aphid, which of late is becoming troublesome, has been controlled with periodical applications of 5 per cent B.H.C. The red headed hairy caterpillar can be collected and destroyed when present in swarms. Leaf spot or tikka often causes 30-50 per cent loss of yield. Some measure of control is obtained by seed treatment with dilute formalin or copper sulphate, or spraying with Bordeaux. Root rot due to **Sclerotium sp.** often causes wilting and death of plants. Another disease rosette causes a dwarfing of the plants and a crowding of leaves. Mosaic is sometimes noticed. Wilt caused by **Rhizoctonia sp.** occurs in a sporadic form, when the crop is raised under irrigation. H.G.1 is partially resistant to tikka and wilt and H.G.10 to tikka leaf spot.

Crop competitions, no doubt serve a purpose in stimulating production. It is proposed to organise such competitions for groundnut.

The two Five Year Plans postulate that productions should be increased, without any undue expansion of the area. The area under groundnuts in the State is continually expanding and if the present trend continues, it may be expected to reach 6 lakhs of acres by 1960-61. The yield per acre has to be stepped up by 25 per cent over, the present 0.28 ton. The salient measures to be adopted to achieve the target set are:—

1. Raise improved varieties as seed becomes available.

2. Prepare a clean seed bed, sow quality seed, and sow as early as possible in the season.

3. Space plants 9 inches either way, or 6 inches in rows 12 inches apart, or 4 inches in rows 18 inches apart.

4. Try to apply farmyard manure or compost 1 ton, super-phosphate 1 cwt., muriate 90 lb. and lime 100 lb. per acre.

5. Weed as early as possible, and as often as required.

6. Employ remedial measures in time to control pests and diseases.

7. Harvest when the crop is completely ripe, dry and clean the pods well before sale or storage.

# NEEM AND ITS USES

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**The tree is common in Mysore. Over 970 tons of fruits are collected and crushed. This quantity is only ¼ of the total production. Annually 60 tons of oil and 175 tons of cakes are produced. There is no wholesale trade in the produce. The uses of the tree and oil are mentioned.**

The recent chronic shortage of fats and oils has revived interest in the greater utilisation of so called minor oilseeds. Important among them in Mysore are **Honge** (Pongamia Pinnata) and **Bevu** or **Neem** (Azadirachta indica). A more extensive use of these oilseeds, oils, and cakes than at present. in industry and agriculture would in turn release more edible oils for human consumption and oil cakes as cattle feed.

**Neem** or true neem is a medium sized tree fairly common throughout India, except in the north and west. Its seed is the principal source of neem oil and neem cake. Two other closely related species are also common in Mysore. One of these is **Melia azedarach**, a small tree common throughout the plain country. This tree also otherwise called as the Persian lilac or Bead tree is much raised around human habitations. Though the seeds are rich in oil. it is hardly of any commercial importance. The plant is pollarded so severely to furnish forage for sheep and goats, that it presents a common unsightly appearance. The seeds are often made into rosaries. The other species is **M. composita** or Giant Neem, a lofty tree of ghat forests. It is little used for building purposes and agricultural implements. Exploitation of the wood in the manufacture of matches and pencils appears to be worth-while. The dried fruits are sometimes collected on account of their value in indigenous medicine.

The true neem belongs to the family Meliaceae. and is an object of reverence by Hindus. It occurs wild in Burma and elsewhere. In other places it is raised by planting and is naturalised. At present the tree is found wild in dry forests of Deccan. It is found to thrive on all kinds of soils, but especially so on black cotton soils. The tree is eminently suited for purposes of afforestation in arid regions. and is also a useful avenue tree.

For purposes of worship. neem is frequently raised along side of **Ficus religiosa** or the sacred peepul. The presence of the tree around villages is considered beneficial to health. All parts of the tree contain a bitter principle and are used in indigenous medicine. From the bark there exudes a bright amber coloured gum, which is esteemed as stimulant. The bark and leaves are often used as a substitute for quinine. The bark is also employed as an astringent and bitter tonic. The leaves and flowers are widely used in the treatment of infectious diseases. They find extensive use as external applicants, and also are administered internally. The leaves are used as preservative for books, fabrics, and grain and also as an insecticide. The twigs are widely used as tooth brushes. The sap is used as a cooling drink, a stomachic, and is sometimes made into toddy since it has a sugar content of over six per cent. The seeds are used as an insecticide and a delousing agent. The fruits are considered as a purgative, emmolient, and wormicide. The oil is used in the treatment of leprosy, rheumatism, as a vermifuge and antiseptic. The oil is also used to kill borers attacking valuable trees. Other uses for the oil are in dyeing, soap manufacture, and as an illuminant. The cake is a useful manure. The wood is durable, hard, close grained, and weighs 50-52 lbs. per cubic foot. The sapwood is grey and the heart wood red. The timber seasons well and is durable even when exposed. It is much used for purposes of building, furniture, and agricultural implements. It is suitable for carving but does not take polish well. Next to teak, it is reputed to be proof against the attack of white ants.

Though the tree is common in most parts of India, commercial exploitation of the produce is mainly confined to Uttar Pradesh and Mysore. Annually, 500 tons of seed are estimated to be crushed in Uttar Pradesh resulting in 200 tons of oil. The production in Mysore comes next. Formerly a certain quantity of seed and oil from Mysore, used to find its way into Ceylon through the port of Madras.

A rough estimate of the number of trees in Mysore is 1,74,000. The district of Chitaldurg has 50,000 trees, the maximum number found in any district. Tumkur, Bellary and Kolar are next in importance. These four districts account for 80 per cent of the total number of trees in the State. On an average, a well grown tree will yield 50 to 60 lbs. In practice only a part of the total yield is collected. It is estimated that only a fourth part of the total produce is actually collected. The availability of the seed more or less coincides with the commencement of the pre-monsoon rains, and the break of the monsoon. This combined with the busy agricultural season leads to much delay and sad neglect in the collection and drying of fruits. In some parts of the State though neem trees abound, the seed is not collected. The reason adduced being that the return is not commensurable with the pains taken for collection. The moist seeds deteriorate rapidly resulting in oil of poor quality and less of it. If held in bulk for sometime, the produce gets heated up and even charred.

Annual production is estimated to be 970 tons of fruits, which on shelling yield about ¼ of the quantity of kernels or approximately 240 tons. Arrival of seed commences in late May and lasts till early September. Heavy arrivals take place during June-July. Seed is usually dealt with in retail, at village shandies. Chitaldurg and Tumkur markets deal with the seed in some bulk. The seed is usually crushed immediately, mostly in village ghanies. Oil and cake are also disposed off locally, in retail. The kernels contain 35-40% of oil, but actual extraction accounts for only 24-26 per cent. The production of oil amounts to 60 tons, and cake 175 tons. These are traded in small quantities, and no local market has any appreciable trade, either in oil or in cake. The produce does not figure in the import and export trade of the State.

# "RICE BRAN OIL"

## A REMEDY TO MEET THE SHORTAGE OF EDIBLE FATS IN INDIA

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**Recovery of oil from rice bran is suggested as a remedy to meet the deficit in edible fats in India. It is expected that if oil from the rice bran is recovered it will enrich the present supply of edible oils by 14% without bringing pressure on the limited cultivable land of our country.**

**Besides the edible oil the bran will supply hard wax, vitamins and phosphatides. After the recovery of these valuable substances the bran is still useful as a cattle feed since the protein remain undisturbed and small quantities of vitamins are retained in it. The extracted bran can also be useful as a source of furfural ·**

**In short the proper exploitation of the rice bran will enrich our country by 50 crores of rupees worth of useful products in the form of oil, hard wax, vitamins, phosphatides, etc. In addition it will add to the Government exchequer 8-9 crores of rupees by way of income tax, sales-tax, general tax and offer new employment to about 5 lakhs of persons.**

It is well known that per capita consumption of edible fats in India is hardly 0.5 oz. per day, while nutritional experts recommend at least 2.0 ozs. of fats per day. It is obvious, therefore, that we must exert to increase the output of edible fats to at least four times that of our present production. Several remedies are suggested to meet the shortage of edible fats of which following are feasible ones :

1. Bringing more areas under edible oilseed cultivation.
2. Increasing the yield of oilseeds per acre by using selected strains of seeds and better agricultural methods.
3. Adoption of efficient processes for the extraction of oil from the seeds and the cake, e.g., solvent extraction of cake, improved oil mills, etc.
4. Increasing the production of ghee, butter and other edible animal fats.
5. Employing non-edible oils and oilseeds for industrial uses of oils, e.g., (1) using neemseed oil, khakan fat in soaps instead of groundnut oil

and cocoanut oil; (2) using dehydrated castor oil for paint industry and releasing linseed oil for edible purpose; (3) using castor oil and other non-edible oils for lubrication; etc.

6. Exploiting yet untapped resources of oils, such as, cottonseed, rice bran, etc.

7. Importing edible fats from other countries.

No sane Indian will like to advocate the last remedy to fill up the shortage of edible fats, when she is able to produce such a large variety and quantity of oilseeds. Bringing more area under the cultivation of oilseeds would be rather difficult, since the available land that can be cultivated is limited and it has to be carefully used for the food-grains. Increasing the yield per acre of the oilseeds would be very much helpful and attempts in that direction would yield good dividends. However, the process is bound to be slow, since improvements in strains and intensive agriculture cannot be achieved overnight. Progress in the dairy industry is also bound to be slow and therefore, stress is laid on improved methods of expression of oils. Better machinery for expression of oils, solvent extration of oilseeds and recovery of residual oil from the oilcakes are advocated and it is shown that solvent extration of oilcake alone would add about 2 lakh tons of oil to our present resources every year. Another advantage of establishing the solvent extration plants for the extration of oils is the exploitation of oilseeds containing less than 20% oil.

The substitution of non-edible oils for the edible oil at present used in industry for the manufacture of soaps, paints and lubricants, etc. has also to be progressively carried out, since it will release quite a large amount of oil for edible use. The sixth item from the above list is perhaps the most promising remedy to meet acute shortage of the edible oils in our country. Since cottonseed and rice bran are by-products of cotton and rice respectively, no pressure on the limited cultivable land of our country will be exerted during the exploitation of the oil from these sources. This is a great advantage indeed. It is reported that about 16 lakh tons of cottonseed is produced annually in India, but only a negligible quantity of oil is expressed from the cottonseed in this country. Perhaps the conventional prejudices of our farmers and dairymen come in way of the proper utilization of the cottonseed by expressing it for its oil. According to the first Five-Year Plan the production of the cottonseed in 1955-56 is expected to be 22.5 lakh tons from which 2.5 lakh tons of oil valued at about 26 crores of rupees could be produced. Assuming that 45 lbs. of edible fats are to be supplied per head per year than the nett shortage of edible oil in this country would be about 50 lakh tons per year. Thus cottonseed alone would reduce shortage of the edible oil by 5 per cent.

Another equally promising source of edible oil is the rice bran oil. India is one of the biggest producers of rice in the world with about 400 lakh tons of paddy to her credit. This yields about 270-280 lakh tons of unpolished rice of which about 60% is reported to be hand-polished and the rest machine-polished. Handpounding produces on an average 4% bran and the machine-polishing upto 10%. On an overall average about 16.3 lakh tons of rice bran may be estimated to be produced each year in the country. Fresh bran contains about 14 to 17% of edible oil on a moisture free basis, and contains in addition proteins, vitamins and phosphatides, derived from the aleurine layer of the pericarp of rice. Another important constituent of the rice bran oil is the small percentage of hard wax of the melting point 80-83°C. (India is woefully short in the supply of hard waxes.) Analysis of samples of rice bran show the following average percentages of the oil, wax, vitamins, etc(1).

14-17% edible oil, hard wax melting point 80-83°C. —0.5 to 1.8%—, phosphatides and vitamins—0.08 to 0.1%. The vitamins comprise of following useful substances: biotin, folic acid, riboflavin, pantothenic acid, pyridoxine, thiamin, niacin and inositol. Rice oil is very good edible oil. Its value as an edible oil is enhanced by refining. The composition of the rice oil as given by Murti and Dollear (2) is as follows:—

Iodine value 102.3; sap. value 181.6; titer 25.2°C.; ref. index at 25°C.—1.4708; colour—Lovibond 35 Y, 6.5 R, B O; Sp.Gr. 25/25°C.—0.966; hydroxyl value—5.0; saturated acids—17.1; oleic acid—46.3%; linoleic acid 33.1%; linolenic acid—0.8%; unsaponifiable matter 2.70%.

The composition will slightly vary from sample to sample depending upon the strain of the rice and climatic condition of the place of growth.

If the available rice bran is processed for the oil our country will be richer by about 2.5 lakh tons of edible oil of the value of about 25 to 26 crores of rupees. It is estimated that the present consumption of oils and fats for edible purpose is about 17.5 lakh tons. Thus the addition of 2.5 lakh tons of oil to this consumption means increase in the fats consumed by about 14%. This would be a good achievement indeed in supplying the necessary nutrition to our poorly fed nation.

Besides the advantage of supplying the edible oil, the rice bran is also an important raw material for the hard wax contained in it. The shortage of raw materials containing hard wax is so well known that the scientists and the industrialists will heave a sigh of relief if they are shown any good source of this material. Hard and soft waxes have their own important place in the industrial life of a country. India produces only bees wax on a commercial scale and imports substantial amounts of hard waxes such as the carnauba, paraffin, etc. Carnauba is one of the costliest waxes and is used for carbon papers, floor and shoe polishes. Other waxes are used in candle compositions, pyrotechnics, electrical insulation, leather and rubber industry, lubrication, antioxidants, match industry, moulding and casting compositions and many other miscellaneous applications. By adopting proper methods of extraction about 15-25 thousand tons of hard wax can be obtained from the rice bran. On a modest estimation the hard wax from rice bran will enrich our country by 10-15 crores of rupees.

Although the value of the vitamins and phosphatides available from the rice bran cannot be estimated very accurately still it can be anticipated that these will yield about couple of crores worth of useful products. The bran after extraction of the above products can still be used as a cattle feed or as filler for such materials as masonite, hardboards, sound-proof lining, etc. The extracted rice-bran can also be contemplated as a source of furfural, which is useful as a raw material for the manufacture of several organic chemicals. In short it will not be too ambitious to say that rice bran is a potential source of about Rs. 50 crores worth of useful products.

The industry of extracting oil from the rice bran is a well-established industry in countries, such as U.S.A., Japan, etc. In the former country solvent extraction is used for getting the oil while in the latter, both solvent extraction of battery type and hydraulic presses of cage type are used to get the oil. In 1949-50 Japan produced 20,000 tons of rice bran oil. But no attention is given to recover the wax, vitamins and phosphatides from the bran in any of these countries. The main difficulty experienced in the extraction of oil from the rice bran is the hydrolytic activity of the lipase that is present in bran. In a few days the acidity in the bran increases to such an extent that the oil shows acid value of the order of 50-60 units. However, this difficulty is not an unsurmountable one, since it has been shown by Y. K. Raghunathrao, (5) and R. G. Krishna Murthy that heating the rice bran to 105°C. destroys the activity of lipase and the bran can be preserved without much development of acidity for over a month.

Another point worth noting in the extraction of the oil from rice bran is that, due to the low oil contents solvent extraction methods are recommended for recovering the oil. Therefore, the success of the industry will much depend upon the development of the solvent extraction plants in the country. At the same time research on other methods of recovering oil from seeds and material containing low oil contents must be carried out. Methods evolved at Forest Research Institute (3) and at the National Chemical Laboratory of India, Poona (4) are the steps in the right direction. It is essential to note that methods not involving the use of volatile solvents would be preferable since with such methods it is possible to carry the industry into small towns at least, if not to the villages. In one of the earlier paragraphs it is mentioned that 60% of the rice is polished by hand pounding and only 40% is polished by mills. The present policy of the Government also favours the hand-pounding with the result that most of the bran will be produced in small quantities and in isolated places. Only Bombay and Madras States have well established mill polishing industry, and in other States, i.e., Bihar, most of the rice is hand-pounded. Our aim should, therefore, be to develop methods which would be useful in villages. The author is quite optimistic, (taking into consideration the recent scientific advance) that such methods can be evolved with some amount of effort in the proper direction.

Let us hope that the public, the businessmen and the government give due thought to the above suggestion and evolve a new industry, which will supplement our present poor supplies of edible oil and will create additional employment in the country. It is expected that the development of the Industry of the recovery of oil and the accompanying products from the rice bran will offer employment to at least five lakhs of persons and will add to the Government exchequer at least 8-9 crores of rupees by way of income tax, general tax, sales tax, etc.

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# "STUDIES ON INDIAN COTTONSEED AND COTTONSEED OIL—THEIR COMPOSITION AND TECHNOLOGY—PART III—PRELIMINARY STUDIES".

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**The analytical data of a further 120 representative samples of different Desi and American varieties of Cottonseed from 12 States in India, is presented. The oil content of the seed is found to vary from 12.5% to 22.9 %; the moisture content from 4.2% to 13.9%; the lint (fuzz) content from 1.0% to 15.1%; the length of the naked seed from 4.3 mms to 11.0 mms. and the F.F.A. of the oil in the sample from 0.44% to 9.8%. The protein content determined on 25 samples from different States varied from 15.7% to 26.9%. These physical and chemical characteristics of Indian cottonseed are compared to the American cottonseed. The variation of the oil content of the seed with the early, middle and late stages of the harvesting (picking) period is discussed on the basis of the data obtained. The suitability of some Desi Variety seeds for oil milling, instead of utilising merely for cattle feed is called to attention.**

In the two earlier papers (1, 2.) of this series, the need for a systematic study of the composition of the different commercially produced varieties of Indian cottonseed in different localities of the country over 3 or 4 continuous seasons as a primary requisite for the studies on cottonseed milling and to ascertain the scope for the establishment of the milling industry in any particular locality, was explained. In the first paper (1), the data obtained by such studies on 50 representative samples drawn from 8 States from the harvesting season of 1951-52 and in the second paper(2) data on 60 representative samples drawn from 10 States (13 from 1951-52 and 47 from 1952-53 harvesting seasons), were published. In the present paper, similar data obtained on 120 samples (49 from 1952-53 and 71 from 1953-54), drawn from 12 States is presented. Of the 230 samples analysed and presented so far, 144 samples are of Desi and 86 of American varieties.

**Experimental:**

As already stated (1, 2.) the representative samples of cottonseed are obtained from the various States through the officers of their respective Agricultural Departments, drawn by them according to accepted sampling methods for oilseeds. The A.O.C.S. Methods (with slight modifications wherever found necessary) are adopted in the analysis of the seeds and all estimations are made in duplicates. As before, the moisture, oil and lint (fuzz) content of the seeds and the F.F.A. of the oil in all the seeds have been determined. In addition to these the lint content of all the 29 samples not previously reported (1, 2,) and the maximum and minimum lengths of the naked seed in all the present (120) and the previous (110) samples have been determined by actual measurement of not less than 10 seeds of each variety. For purposes of comparison, oil and lint contents are also calculated on the basis of 10% moisture in the seed. The data is presented in Table I.

### TABLE I

**Data on the analysis of Cottonseed of different**

| Serial No. | Sample No. | Variety of the seed | Botanical species of the seed | Harvesting (picking) period of the sample | Locality and District |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | | | | | 1. **ANDHRA** |
| 1. | S-160 | Hingari | G. Herbaceum | Middle | Proddutur (Cuddapah) |
| 2. | S-169 | Chinnapathi | G. Arboreum | — do — | Narsipatnam (Visakhapatnam) |
| 3. | S-297 | Coconadas | — do — | — do — | Sattenapalli (Guntur) |
| 4. | S-325 | Lakshmi | G. Hirsutum | — do — | Adoni (Kurnool) |
| 5. | S-326 | — do — | — do — | Late | — do — |
| 6. | S-328 | Mungari | G. Herbaceum | Early | Yemmiganur (Kurnool) |
| 7. | S-329 | — do — | — do — | Middle | — do — |
| 8. | S-330 | — do — | — do — | Late | — do — |
| 9. | S-370 | Desavali | G. Arboreum | Middle | Kanigiri (Nellore) |
| 10. | S-390 | N-14 Northerns | — do — | — do — | Nandyal (Kurnool) |
| 11. | SN | Red Northerns | — do — | ...... | — do — |
| 12. | SA | Mungari | G.Herbeceum | ...... | Adoni (Kurnool) |
| 13. | S-396 | Red Cotton-seeds | G. Arboreum | Middle | Nandyal (Kurnool) |
| 14. | S-398 | Local Cotton-Seeds | — do — | — do — | Srikakulam (Srikakulam) |
| | | | | | 2. **BOMBAY** |
| 15. | S-173 | Virnar | G. Arboreum | Early | Sindkheda (West Khandesh) |
| 16. | S-188 | — do — | — do — | Middle | — do — |
| 17. | S-176 | — do — | — do — | Early | Dharangaon (East Khandesh) |
| 18. | S-177 | — do — | — do — | Middle | — do — |
| 19. | S-186 | — do — | — do — | Early | Sawada (East Khandesh) |
| 20. | S-187 | — do — | — do — | Middle | — do — |
| 21. | S-196 | Pratap | — do — | ...... | Damnagar (Amreli) |
| | | | | | 3. **HYDERABAD** |
| 22. | S-112 | Gaorani 12 | G. Arboreum | Early | Latur (Latur) |
| 23. | S-113 | — do — | — do — | Middle | — do — |
| 24. | S-114 | — do — | — do — | Late | — do — |
| 25. | S-118 | Jaidhar | G. Herbaceum | Early | Raichur (Raichur) |

**Varieties from the different States in India.**

| Moisture per cent. | Oil content of the seed (on the moisture basis in the sample) per cent | Lint per cent. | OIL on 10% moisture basis. per cent. | LINT on 10% moisture basis. per cent. | F.F.A of oil in seed per cent. | Length of naked seed in Milimeters. |
|---|---|---|---|---|---|---|
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **STATE** | | | | | | |
| 8.0 | 16.0 | 3.7 | 15.6 | 3.6 | 2.7 | 5.0 — 7.3 |
| 6.6 | 19.4 | 4.5 | 18.7 | 4.3 | 1.0 | 5.3 — 7.0 |
| 10.3 | 18.2 | 5.7 | 18.3 | 5.8 | 2.7 | 5.3 — 7.9 |
| 5.7 | 16.9 | 10.5 | 16.1 | 10.2 | 0.51 | 5.0 — 7.8 |
| 9.3 | 18.2 | 13.1 | 18.1 | 13.0 | 1.0 | 6.4 — 8.0 |
| 9.8 | 15.1 | 3.8 | 15.0 | 3.7 | 1.3 | 4.5 — 7.1 |
| 9.5 | 16.0 | 3.7 | 15.9 | 3.6 | 2.4 | 4.4 — 7.7 |
| 10.3 | 16.1 | 4.3 | 16.2 | 4.4 | 3.3 | 5.4 — 8.1 |
| 6.6 | 21.8 | 10.7 | 21.0 | 10.3 | 1.2 | 5.1 — 7.6 |
| 8.0 | 16.2 | 7.3 | 15.8 | 7.1 | 3.2 | 4.6 — 6.5 |
| 6.2 | 17.5 | 3.8 | 16.8 | 3.6 | 1.3 | ... |
| 11.5 | 18.2 | 3.6 | 18.5 | 3.8 | 1.9 | ... |
| 8.0 | 16.2 | 1.9 | 15.8 | 1.9 | 0.71 | 4.8 — 6.8 |
| 7.3 | 18.8 | 4.7 | 18.3 | 4.6 | 1.4 | 5.3 — 7.6 |
| **STATE.** | | | | | | |
| 6.5 | 19.1 | 6.6 | 18.4 | 6.4 | 0.90 | 5.8 — 7.5 |
| 5.9 | 17.7 | 4.4. | 16.9 | 4.2 | 1.8 | 5.1 — 7.4 |
| 5.7 | 19.4 | 2.9 | 18.5 | 2.8 | 0.50 | 5.5 — 7.3 |
| 5.8 | 19.7 | 2.8 | 18.8 | 2.7 | 0.54 | 5.3 — 7.1 |
| 5.9 | 19.3 | 3.8 | 18.5 | 3.6 | 0.84 | 5.2 — 7.2 |
| 5.8 | 18.3 | 4.0 | 17.5 | 3.8 | 1.2 | 5.3 — 7.4 |
| 5.8 | 19.0 | 3.1 | 18.2 | 3.0 | 0.90 | 4.8 — 7.2 |
| **STATE** | | | | | | |
| 8.8 | 17.2 | 3.5 | 17.0 | 3.5 | 2.0 | 4.9 — 8.0 |
| 7.5 | 17.5 | 3.8 | 17.0 | 3.7 | 1.3 | 5.1 — 8.2 |
| 8.3 | 17.3 | 5.2 | 17.1 | 5.1 | 1.3 | 4.9 — 8.1 |
| 11.0 | 12.5 | 1.7 | 12.6 | 1.7 | 1.5 | 6.0 — 7.8 |

TABLE I

| Serial No. | Sample No. | Variety of the seed | Botanical species of the seed | Harvesting (picking) period of the sample | Locality and District |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 26. | S-119 | Jayawant | — do — | — do — | — do — |
| 27. | S-121 | — do — | — do — | Middle | — do — |
| 28. | S-120 | Lakshmi | G. Hirsutum | Early | — do — |
| 29. | S-122 | Gaorani 12 | G. Arboreum | ...... | Aurangabad (Dt) |
| 30. | S-130 | — do — | — do — | ...... | Latur (Latur) |
| 31. | S-180 | — do — | — do — | Early | Udgir (Bidar) |
| 32. | S-193 | — do — | — do — | — do — | Latur (Latur) |
| 33. | S-203 | Gaorani 6 | — do — | — do — | Bhainsa (Nanded) |
|  |  |  |  |  | **4. MADHYA** |
| 34. | S-129 | Malvi (Gwalior 16) | G. Arboreum | Late | Ujjain (dt.) |
| 35. | S-139 | Indore 2 | G. Hirsutum | Middle | Dewas (dt.) |
| 36. | S-140 | Bhoj | ...... | Middle | Indore (Dt.) |
| 37. | S-141 | Malvi 9 | G. Arboreum | — do — | Dewas (Dewas) |
| 38. | S-143 | Buri | G. Hirsutum | — do — | Kannod (Dewas) |
| 39. | S-144 | Jarilla | G. Arboreum | — do — | Indore (Indore) |
| 40. | S-145 | — do — | — do — | — do — | Dewas (Dewas) |
| 41. | S-146 | Bhoj | ...... | — do — | — do — |
| 42. | S-147 | Malvi 9 | G. Arboreum | — do — | Indore (Indore) |
| 43. | S-153 | — do — | — do — | Early | Manasa (Mandsaur) |
| 44. | S-155 | — do — | — do — | Late | — do — |
| 45. | S-157 | — do — | — do — | Early | Mandsaur (Mandsaur) |
| 46. | S-154 | — do — | — do — | Late | — do — |
| 47. | S-156 | — do — | — do — | Early | Shamgarh (Mandsaur) |
| 48. | S-158 | — do — | — do — | Late | — do — |
|  |  |  |  |  | **5. MADHYA** |
| 49. | S-175 | Jarilla | G. Arboreum | Early | Khamgaon (Buldana) |
| 50. | S-194 | — do — | — do — | Middle | — do — |
| 51. | S-264 | — do — | — do — | Late | — do — |
| 52. | S-227 | 197\|3 Variety | — do — | ...... | Amravathi (Dt.) |
| 53. | S-228 | H. 420 | — do — | ...... | — do — |
| 54. | S-229 | Buri 0397 | G. Hirsutum | ...... | — do — |
|  |  |  |  |  | **6. MADRAS** |
| 55. | S-109 | Madras Uganda I | G. Hirsutum | Early | Sattur (Buldana) |
| 56. | S-111 | Cambodia | — do — | — do — | Salem (Salem) |
| 57. | S-149 | — do — | — do — | Middle | — do — |
| 58. | S-159 | — do — | — do — | Early | Pollachi (Coimbatore) |
| 59. | S-161 | — do — | — do — | — do — | Periyakulam (Madurai) |

(Continued)

| Moisture per cent. | Oil content of the seed (on the moisture basis in the sample) per cent. | Lint per cent. | OIL on 10% moisture basis. per cent. | LINT | F.F.A of oil in seed per cent | Length of naked seed in Milimeters. |
|---|---|---|---|---|---|---|
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 8.2 | 15.9 | 2.5 | 15.6 | 2.5 | 1.7 | 5.8 — 7.6 |
| 7.3 | 15.7 | 3.5 | 15.2 | 3.4 | 1.7 | 4.3 — 7.4 |
| 8.7 | 17.0 | 7.7 | 16.8 | 7.6 | 2.7 | 6.3 — 9.1 |
| 6.9 | 18.3 | 4.9 | 17.7 | 4.7 | 1.9 | 4.6 — 8.4 |
| 5.7 | 18.6 | 8.0 | 17.8 | 7.6 | 0.92 | 5.6 — 7.9 |
| 7.7 | 19.5 | 3.0 | 19.0 | 2.9 | 1.0 | 5.0 — 8.0 |
| 5.2 | 19.9 | 5.6 | 18.9 | 5.3 | 1.3 | 5.3 — 9.6 |
| 8.8 | 16.8 | 1.5 | 16.6 | 1.5 | 2.5 | 5.9 — 8.0 |
| **BHARAT STATE** | | | | | | |
| 5.6 | 20.0 | 7.5 | 19.1 | 7.2 | 1.4 | 5.3 — 6.9 |
| 6.2 | 19.6 | 8.1 | 18.4 | 7.6 | 1.5 | 6.0 — 9.6 |
| 10.7 | 20.0 | 4.1 | 20.2 | 4.1 | 2.1 | 5.5 — 9.2 |
| 7.4 | 17.6 | 4.7 | 17.1 | 4.6 | 1.3 | 5.4 — 8.4 |
| 10.9 | 19.0 | 9.0 | 19.2 | 9.1 | 3.7 | 8.0 — 9.2 |
| 10.8 | 18.9 | 4.1 | 19.1 | 4.1 | 2.8 | 6.1 — 6.9 |
| 9.0 | 18.6 | 5.2 | 18.4 | 5.1 | 3.7 | 5.9 — 7.1 |
| 12.0 | 18.5 | 3.0 | 18.9 | 3.1 | 6.4 | 6.0 — 7.5 |
| 9.0 | 18.9 | 12.5 | 18.7 | 12.4 | 3.8 | 5.6 — 7.6 |
| 10.6 | 17.4 | 4.8 | 17.5 | 4.8 | 2.8 | 6.4 — 8.3 |
| 9.9 | 19.0 | 5.0 | 19.0 | 5.0 | 2.9 | 6.0 — 7.0 |
| 11.2 | 19.2 | 3.6 | 19.5 | 3.6 | 2.1 | 5.8 — 9.3 |
| 11.8 | 17.7 | 7.3 | 18.1 | 7.4 | 3.1 | 8.0 — 9.3 |
| 12.1 | 17.1 | 5.3 | 17.5 | 5.4 | 3.5 | 5.5 — 8.3 |
| 12.5 | 17.6 | 6.8 | 18.1 | 7.0 | 3.0 | 5.6 — 9.0 |
| **PRADESH STATE** | | | | | | |
| 5.7 | 19.0 | 10.4 | 18.1 | 9.9 | 1.1 | 5.1 — 8.0 |
| 6.4 | 18.8 | 5.3 | 18.1 | 5.1 | 0.92 | 5.7 — 7.8 |
| 6.9 | 19.1 | 7.9 | 18.5 | 7.6 | 0.91 | 5.3 — 8.3 |
| 9.0 | 19.7 | 2.8 | 19.5 | 2.8 | 0.85 | 5.4 — 7.7 |
| 9.0 | 19.3 | 4.8 | 19.1 | 4.7 | 0.57 | 5.6 — 9.6 |
| 10.2 | 19.0 | 7.6 | 19.0 | 7.6 | 1.2 | 7.6 — 10.9 |
| **STATE** | | | | | | |
| 9.5 | 17.0 | 11.3 | 16.9 | 11.2 | 3.4 | 5.5 — 9.8 |
| 8.1 | 16.0 | 11.4 | 15.7 | 11.2 | 2.2 | 5.6 — 10.0 |
| 11.4 | 16.0 | 10.6 | 16.3 | 10.8 | 2.2 | 9.2 — 10.2 |
| 12.9 | 19.6 | 15.1 | 20.3 | 15.6 | 3.0 | 5.6 — 9.9 |
| 11.9 | 19.1 | 9.0 | 19.5 | 9.2 | 4.4 | 7.6 — 10.5 |

**TABLE I**

| Serial No. | Sample No. | Variety of the seed | Botanical species of the seed | Harvesting (picking) period of the sample | Locality and District |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 60. | S-162 | — do — | — do — | Late | — do — |
| 61. | S-163 | Madras Uganda 1 | — do — | Early | — do — |
| 62. | S-164 | — do — | — do — | Late | — do — |
| 63. | S-171 | Tinnies | G. Herbaceum | ...... | Thirumangalam (Madurai) |
| 64. | S-174 | Cambodia | G. Hirsutum | Early | Karur (Salem) |
| 65. | S-212 | — do — | — do — | — do — | Villupuram (S. Arcot) |
| 66. | S-213 | — do — | — do — | Middle | — do — |
|  |  |  |  |  | 7. **MYSORE** |
| 67. | S-136 | Jayadhar | G. Herbaceum | Early | Davangere (Chitaldrug) |
| 68. | S-137 | — do — | — do — | Middle | — do — |
| 69. | S-138 | — do — | — do — | Late | — do — |
| 70. | SD | Lakshmi | G. Hirsutum | ...... | Chennagiri (Mysore) |
| 71. | S-232 | M.A. 5 | — do — | Middle | Hassan (Hassan) |
|  |  |  |  |  | 8. **PEPSU** |
| 72. | S-183 | 320 F | G. Hirsutum | Middle | Nabha (Nabha) |
| 73. | S-184 | Desi | G. Arboreum | — do — | — do — |
| 74. | S-197 | 216 F | G. Hirsutum | Early | Barnala (Dt.) |
| 75. | S-199 | — do — | — do — | Middle | — do — |
| 76. | S-198 | — do — | — do — | Late | — do — |
| 77. | S-200 | Desi | G. Arboreum | Early | — do — |
| 78. | S-230 | — do — | — do — | Middle | — do — |
| 79. | S-201 | — do — | — do — | Late | — do — |
|  |  |  |  |  | 9. **PUNJAB** |
| 80. | S-148 | 320 F | G. Hirsutum | ...... | Jullundur (Dt.) |
| 81. | S-150 | Desi | G. Arboreum | Late | Abohar (Ferozpur) |
| 82. | S-151 | L. S. S. | G. Hirsutum | Early | Falilka (Ferozpur) |
| 83. | S-152 | 320 F | — do — | Middle | — do — |
| 84. | S-167 | Desi | G. Arboreum | Early | Karnal (Karnal) |
| 85. | S-168 | 216 F | G. Hirsutum | Early | — do — |
| 86. | S-172 | 320 F | — do — | ...... | Jullundur (Dt.) |
| 87. | S-178 | Desi | G. Arboreum | ...... | Malout (Ferozpur) |
| 88. | S-181 | 216 F | G. Hirsutum | Middle | Karnal (Karnal) |
| 89. | S-185 | 320 F | — do — | Early | Jagraon (Ludhiana) |
| 90. | S-195 | 320 F | — do — | Middle | Jullundur (Dt.) |
| 91. | S-210 | 216 F | — do — | Early | Hodel (Gurgaon) |
| 92. | S-211 | Desi | G. Arboreum | Early | — do — |

(Continued)

| Moisture per cent. | Oil content of the seed (on the moisture basis in the sample) per cent. | Lint per cent. | OIL LINT on 10% moisture basis. per cent. | | F.F.A of oil in seed per cent | Length of naked seed in Milimeters. |
|---|---|---|---|---|---|---|
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 10.0 | 20.1 | 10.6 | 20.1 | 10.6 | 0.93 | 5.7 — 9.6 |
| 9.6 | 16.1 | 13.4 | 16.0 | 13.3 | 5.9 | 7.6 — 10.3 |
| 10.7 | 20.0 | 12.6 | 20.2 | 12.7 | 1.3 | 6.3 — 10.5 |
| 7.7 | 16.5 | 5.4 | 16.1 | 5.3 | 3.2 | 4.9 — 8.4 |
| 6.3 | 19.1 | 12.9 | 18.3 | 12.4 | 1.9 | 5.6 — 9.8 |
| 12.4 | 18.3 | 9.7 | 18.8 | 10.0 | 1.4 | 9.6 — 10.8 |
| 11.8 | 18.0 | 9.7 | 18.4 | 9.9 | 2.6 | 6.5 — 9.5 |
| STATE | | | | | | |
| 8.5 | 16.9 | 3.4 | 16.6 | 3.3 | 1.5 | 5.1 — 7.5 |
| 8.6 | 16.5 | 3.3 | 16.3 | 3.2 | 1.7 | 4.8 — 7.7 |
| 8.8 | 16.8 | 3.3 | 16.6 | 3.3 | 1.6 | 5.3 — 8.4 |
| 9.6 | 18.5 | 8.5 | 18.4 | 8.4 | 1.2 | ...... |
| 11.0 | 19.8 | 7.8 | 20.0 | 7.9 | 6.0 | 6.7 — 10.7 |
| STATE | | | | | | |
| 7.3 | 18.5 | 11.8 | 18.0 | 11.5 | 0.70 | 5.8 — 9.8 |
| 7.8 | 19.3 | 5.1 | 18.8 | 5.0 | 1.5 | 5.4 — 6.9 |
| 4.8 | 20.6 | 8.3 | 19.5 | 7.8 | 2.5 | 6.4 — 8.9 |
| 4.4 | 20.0 | 7.8 | 18.8 | 7.3 | 2.7 | 5.1 — 8.6 |
| 5.3 | 17.7 | 11.0 | 16.8 | 10.5 | 3.4 | 5.5 — 8.8 |
| 5.4 | 18.7 | 6.9 | 17.8 | 6.6 | 2.2 | 5.5 — 7.3 |
| 10.8 | 19.0 | 5.2 | 19.2 | 5.3 | 3.3 | 4.5 — 7.4 |
| 4.2 | 19.3 | 5.8 | 18.1 | 5.4 | 3.5 | 5.1 — 7.6 |
| STATE | | | | | | |
| 13.5 | 17.4 | 4.9 | 18.1 | 5.1 | 4.1 | 8.1 — 9.3 |
| 10.9 | 17.8 | 6.8 | 18.0 | 6.9 | 9.8 | 6.0 — 7.4 |
| 8.8. | 22.2 | 3.2 | 21.8 | 3.2 | 1.8 | 5.9 — 8.7 |
| 9.5 | 22.4 | 1.7 | 22.3 | 1.6 | 2.7 | 5.6 — 8.3 |
| 10.7 | 20.2 | 4.4 | 20.4 | 4.6 | 2.0 | 4.8 — 6.9 |
| 7.3 | 18.7 | 11.8 | 18.2 | 11.4 | 2.7 | 5.3 — 9.6 |
| 5.3 | 21.2 | 10.7 | 20.2 | 10.2 | 1.5 | 5.8 — 8.4 |
| 5.2 | 20.3 | 3.2 | 19.3 | 3.0 | 0.44 | 5.1 — 7.2 |
| 8.3 | 18.5 | 10.9 | 18.2 | 10.7 | 1.2 | 6.9 — 9.9 |
| 7.4 | 21.7 | 8.3 | 21.1 | 8.1 | 0.80 | 5.9 — 10.2 |
| 5.8 | 21.2 | 7.6 | 20.3 | 7.3 | 1.8 | 5.3 — 8.5 |
| 11.9 | 13.8 | 4.5 | 14.1 | 4.6 | 7.6 | 6.1 — 9.0 |
| 11.6 | 15.7 | 8.8 | 16.0 | 9.0 | 3.5 | 4.5 — 7.4 |

**TABLE I**

| Serial No. | Sample No. | Variety of the seed | Botanical species of the seed | Harvesting (picking) period of the sample | Locality and District |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | | | | | 10. **RAJASTHAN** |
| 93. | S-116 | Local Desi | G. Arboreum | ...... | Kapasin (Kapasin) |
| 94. | S-117 | C. Indore I | G. Hirsutum | ...... | — do — |
| 95. | S-123 | Local Desi | G. Arboreum | ...... | Ganga Canal Colony (Sriganganagar) |
| 96. | S-124 | 320 F | G. Hirsutum | ...... | — do — |
| 97. | S-125 | 216 F | — do — | ...... | — do — |
| 98. | S-126 | Desi | G. Arboreum | ...... | — do — |
| 99. | S-127 | L. S. S. | G. Hirsutum | ...... | — do — |
| 100. | S-128 | C. 520 | G. Arboreum | ...... | Malpara (Tonk) |
| 101. | S-131 | L. S. S. | G. Hirsutum | ...... | Sriganganagar (Dt) |
| 102. | S-132 | G. 1 | G. Arboreum | ...... | — do — |
| 103. | S-132 | Desi | — do — | ...... | — do — |
| 104. | S-134 | 216 F | G. Hirsutum | ...... | — do — |
| 105. | S-135 | 320 F | — do — | ...... | — do — |
| 106. | S-165 | Desi | G. Arboreum | Middle | Kapasin (Kapasin) |
| 107. | S-166 | C. Indore I | G. Hirsutum | — do — | — do — |
| | | | | | 11. **SAURASHTRA** |
| 108. | S.110 | Wagad | G. Herbaceum | ...... | Dhrangadhra (Zalawad) |
| 109. | S-115 | Kalagin | — do — | ...... | Manavadar (Sorath) |
| | | | | | 12. **UTTAR PRADESH** |
| 110. | S-170 | Desi | G. Arboreum | Early | Bulandshahr (Dt.) |
| 111. | S-179 | 35/1 Good Desi | — do — | — do — | Meerut (Meerut) |
| 112. | S-180 | — do — | — do — | Middle | — do — |
| 113. | S-192 | — do — | — do — | Late | — do — |
| 114. | S-189 | Desi | — do — | Early | Mathura (Mathura) |
| 115. | S-190 | — do — | — do — | Middle | — do — |
| 116. | S-191 | — do — | — do — | Late | — do — |
| 117. | S-202 | — do — | — do — | Middle | Bulandshahr (Dt.) |
| 118. | S-209 | — do — | — do — | Early | Hathras (Aligarh) |
| 119. | S-216 | — do — | — do — | Middle | Agra (Agra) |
| 120. | S-231 | — do — | — do — | Late | Bulandshahr (Dt.) |

**NOTE:** Samples SA, SN and SD are received from the merchants direct and not in the regular manner. Sample SN was too small to determine the lint content.

(Continued)

| Moisture per cent. | Oil content of the seed (on the moisture basis in the sample) per cent. | Lint per cent. | OIL LINT on 10% moisture basis. per cent. | | F.F.A of oil in seed per cent | Length of naked seed in Mili-meters. |
|---|---|---|---|---|---|---|
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **STATE** | | | | | | |
| 10.4 | 18.3 | 6.0 | 18.4 | 6.0 | 4.5 | 5.2 — 7.1 |
| 9.3 | 19.1 | 6.5 | 19.0 | 6.5 | 3.7 | 6.0 — 10.0 |
| 6.9 | 18.4 | 7.6 | 17.6 | 7.3 | 7.5 | 4.6 — 8.0 |
| 5.8 | 20.4 | 5.8 | 19.5 | 5.5 | 1.7 | 5.6 — 10.1 |
| 4.3 | 19.2 | 12.9 | 18.1 | 12.1 | 1.8 | 6.2 — 9.8 |
| 6.4 | 19.5 | 5.6 | 18.8 | 5.4 | 2.9 | 5.8 — 7.6 |
| 7.4 | 18.9 | 5.6 | 18.4 | 5.4 | 1.8 | 5.3 — 8.5 |
| 7.6 | 18.7 | 5.3 | 18.2 | 5.2 | 8.6 | 5.5 — 7.4 |
| 4.6 | 20.5 | 7.8 | 19.3 | 7.4 | 4.3 | 5.1 — 8.5 |
| 5.1 | 19.7 | 3.7 | 18.7 | 3.5 | 2.0 | 5.1 — 6.7 |
| 6.4 | 19.3 | 7.8 | 18.6 | 7.5 | 2.6 | 4.9 — 7.3 |
| 4.3 | 20.0 | 12.8 | 18.8 | 12.0 | 2.2 | 6.9 — 9.9 |
| 5.8 | 20.4 | 5.8 | 19.5 | 5.5 | 2.0 | 6.0 — 10.0 |
| 10.6 | 20.8 | 8.8 | 20.9 | 8.9 | 0.69 | 6.4 — 9.6 |
| 9.6 | 22.9 | 9.1 | 22.8 | 9.0 | 0.82 | 6.8 — 11.0 |
| **STATE** | | | | | | |
| 7.5 | 15.8 | 4.5 | 15.4 | 4.4 | 2.0 | 5.8 — 7.0 |
| 8.6 | 16.5 | 5.2 | 16.3 | 5.1 | 1.2 | 5.4 — 7.0 |
| **STATE** | | | | | | |
| 7.3 | 19.4 | 5.1 | 18.8 | 5.0 | 2.5 | 5.2 — 7.1 |
| 7.5 | 17.7 | 8.5 | 17.2 | 8.3 | 0.90 | 5.0 — 7.1 |
| 7.6 | 17.0 | 7.5 | 16.6 | 7.3 | 0.80 | 4.9 — 7.0 |
| 4.7 | 18.1 | 9.9 | 17.1 | 9.3 | 2.0 | 5.9 — 7.0 |
| 6.5 | 18.0 | 5.3 | 17.3 | 5.1 | 2.4 | 5.2 — 7.0 |
| 6.6 | 18.3 | 4.5 | 17.6 | 4.3 | 2.5 | 5.3 — 6.7 |
| 6.2 | 17.3 | 5.2 | 16.6 | 5.0 | 1.8 | 5.2 — 7.3 |
| 6.2 | 18.5 | 5.4 | 17.7 | 5.2 | 4.8 | 5.1 — 6.7 |
| 13.9 | 13.8 | 1.0 | 14.4 | 1.0 | 3.5 | 6.1 — 7.9 |
| 10.8 | 14.7 | 6.0 | 14.8 | 6.1 | 2.4 | 4.5 — 7.1 |
| 10.9 | 15.5 | 4.4 | 15.7 | 4.5 | 5.2 | 5.4 — 8.7 |

## Discussion of Results.

It will be seen from the data in Table I that the oil content of these seed samples varies from 12.5% to 22.9%, the moisture content from 4.2% to 13.9% the lint (fuzz) content from 1.0% to 15.1%, the F.F.A. of the oil in the sample from 0.44% to 9.8% (calculated as oleic acid). The oil and lint (fuzz) contents of the American Varieties of Indian Cottonseed given in the table vary respectively from 14.1% to 22.8% and 1.6% to 15.6% as compared with the corresponding values for the Desi varieties of 12.6% to 21.0% for oil and 1.0% to 12.4% for lint, on a 10% moisture basis in both cases. The F.F.A. of the oil in the Desi seeds varies from 0.44% to 9.8% where as it varies in the American variety seed from 0.51% to 7.6%.

The length of the Indian Cottonseed of all varieties is also given in Table I. It varies from 4.3 mm to 11.0 mm. The length of the Desi variety seeds varies from 4.3 mm to 9.9 mm and that of the American varieties from 9.6 mm to 11.0 mm. Thus while the length of American variety seeds grown in India is definitely longer and bigger than the Desi varieties even these Indian American seeds are somewhat smaller than the cottonseed produced in America, the length of which varies from 8 mm to 12 mm (3). This aspect of the size of Indian seeds has a bearing in going in for the American equipments for processing Indian seeds, when screens of suitable sizes both for the seed cleaning and dehulling equipment may have to be obtained additionally.

Among the Desi varieties so far tested, cottonseed belonging to the "Gossipium Arboreum" species such as Northerns, Coconadas, Gaoranis, Jarillas, Virnars, Punjab Desi, U. P. Desi are found less fuzzy generally (varying from 1.0% to 12.5%), than the Desi cottonseeds belonging to the species of "G. Herbaceum" such as Hingaris, Mungaris, Tinnies, Jayadhar, Jayawant, Kalagin, Wagad, which are found to have a lint (fuzz) content varying from 1.1% to 15.2%. The "Arboreum" cottonseeds also seem to exhibit a wider range of seed size as shown by their length (4.5 mm to 9.9 mm) than that of the "Herbaceum" seeds varying from 4.3 mm to 8.4 mm which is characterised by a greater uniformity in the seed size than the "Arboreum" group. This inference is also supported by an earlier observation made at the Agricultural Research Station, Coimbatore (4).

With a view to find out how far the average value of the duplicate experiments on oil content of the cottonseed samples, represents the correct oil content of the particular seed sample, three different samples already analysed were selected and four more values for oil content determined for each sample. The analytical data of the three samples is given in Table II. together with the dates of determination of the corresponding values.

## TABLE II

### Oil Content of Three Cottonseed Samples Determined at Different times:

| S. No. 1 | Sample No. 2 | Variety and locality of the seed. 3 | Date of determination of **oil** content. 4 | Oil Content per sent. 5 | Average. 6 |
|---|---|---|---|---|---|
| 1. | S-212 | C.O.4<br>Villupuram<br>(Madras) | 6-9-54 | 18.4<br>18.2 | 18.3 |
| | ,, | —do— | 15-11-54 | 17.1<br>18.1<br>17.4<br>17.6 | 17.6 |
| 2. | S-265 | Vijay (Baroda-Bombay) | 21-9-54 | 19.1<br>19.3 | 19.2 |
| | ,, | —do— | 15-11-54 | 18.0<br>18.0<br>17.7<br>18.1 | 18.0 |
| 3. | S-328 | Mungari Yemmiganur (Andhra) | 23-8-54 | 15.3<br>15.1 | 15.2 |
| | ,, | —do— | 15-11-54 | 15.2<br>15.2<br>15.3<br>15.8 | 15.4 |

From the individual as well as average values given in Table II, (taking into consideration, the time factor and that the two sets of values are determined by two different persons), it is considered that the duplicate values for oil content being determined so far will properly represent the oil content of the bulks which the samples represent.

The protein content of 25 samples of cottonseeds of both the Desi (16) and American (9) varieties obtained from all the States are also determined. The data is given in Table III.

## TABLE III

Giving the Protein content of 25 Cottonseed samples of different Desi and American varieties of the different States.

| Serial No.<br>(1) | Sample<br>(2) | Variety<br>(3) | Locality and State<br>(4) | Protein content on moisture free basis per cent.<br>(5) |
|---|---|---|---|---|
| 1. | S-160 | Hingari (Desi) | Proddutur (Andhra) | 17.4 |
| 2. | S-169 | Chinnapathi (Desi) | Narsipatnam (Andhra) | 18.1 |
| 3. | S-297 | Coconadas (Desi) | Sattenapalli (Andhra) | 26.9 |
| 4. | S-176 | Virnar (Desi) | Dharangaon (Bombay) | 20.4 |
| 5. | S-196 | Pratap (Desi) | Damnagar (Bombay) | 26.9 |
| 6. | S-121 | Jayawant (Desi) | Raichur (Hyderabad) | 19.6 |
| 7. | S-193 | Gaorani 12 (Desi) | Latur (Hyderabad) | 16.8 |
| 8. | S-142 | Malvi 9 (Desi) | Kannod (Madhya Bharat) | 18.8 |
| 9. | S-153 | Buri local (American) | —do— | 21.4 |
| 10. | S-145 | Jarilla (Desi) | Dewas (Madhya Bharat) | 19.5 |
| 11. | S-175 | — do — | Khamgaon (Madhya Pradesh) | 18.8 |
| 12. | S-149 | Cambodia (American) | Salem (Madras) | 20.7 |
| 13 | S-164 | Madras Ugandas I (American) | Periyakulam (Madras) | 20.5 |
| 14. | S-171 | Tinnies (Desi) | Thirumangalam (Madras) | 15.7 |
| 15. | S-174 | Cambodia (American) | Karur (Madras) | 21.3 |
| 16. | S-98 | M. A. 5 (American) | Mandya (Mysore) | 18.9 |
| 17. | S-136 | Jaydhar (Desi) | Davangere (Mysore) | 18.1 |
| 18. | SD | Lakshmi (American) | Chennagiri (Mysore) | 19.6 |
| 19. | S-150 | Local Desi | Abohar (Punjab)* | 17.0 |
| 20. | S-151 | L.S.S. (American) | Fazilka (Punjab) | 17.5 |
| 21. | S-152 | 320 F (American) | — do — | 18.1 |
| 22. | S-168 | 216 F (American) | Karnal (Punjab) | 17.4 |
| 23. | S-81 | Kalyan (Desi) | Zalawad (Saurashtra) | 18.8 |
| 24. | S-170 | Desi | Bulandshahar (Uttar Pradesh) | 16.3 |
| 25. | S-179 | 35/1 Good Desi | Meerut (Uttar Pradesh) | 25.5 |
| | | | Average of all the values | 19.3% |

*Punjab varieties represent the cottonseed grown in PEPSU and Rajasthan States also.

From the above data it is seen that the protein content of American variety seeds produced in India is about the same as that of the Desi seed, whereas the protein content of cottonseeds in America varies from 22.1% to 24.8%, having an average of 23.1%(5).

**Variation of Oil content of the seed with the harvesting (picking) period.**

Although strenuous efforts have been made during the last three years to get samples representative of the bulk production of cottonseed from the early, middle and late harvesting (picking) periods for each variety from all the different localities, with a view to study how the oil content of the seed varies with the—early and late—developing BBlls. only 22 such samples are obtained and analysed so far, for the same variety and from the same locality. Out of these only 8 samples are available from the early, middle and late pickings, 7 from early and middle pickings and 6 from early and late pickings and only one from the middle and late pickings. The data is presented in Table IV.

## TABLE IV.

**Oil Content of Cottonseed from Early and Late Developing Bolls of Cotton**

| S. No. 1 | Sample No. 2 | Variety 3 | Locality (and District) 4 | Harvesting (picking) period 5 | Oil content (per cent) 6 | Moisture content per cent 7 | Oil content on 10% Moisture basis 8 |
|---|---|---|---|---|---|---|---|
| 1. | S-328 | Mungari | Yemmiganur (Kurnool) | Early | 15.1 | 9.8 | 15.0 |
| | S-329 | -do- | -do- | Middle | 16.0 | 9.5 | 15.9 |
| | S-330 | -do- | -do- | Late | 16.1 | 10.3 | 16.2 |
| 2. | S-112 | Gaorani | 12 Latur (Latur) | Early | 17.2 | 8.8 | 17.0 |
| | S-113 | -do- | -do- | Middle | 17.5 | 7.5 | 17.0 |
| | S-114 | -do- | -do- | Late | 17.3 | 8.3 | 17.1 |
| 3. | S-175 | Jarilla | Khamgaon (Buldana) | Early | 19.0 | 5.7 | 18.1 |
| | S-194 | -do- | -do- | Middle | 18.8 | 6.4 | 18.1 |
| | S-264 | -do- | -do- | Late | 19.1 | 6.9 | 18.5 |
| 4. | S-136 | Jayadhar | Davangere (Chitaldrug) | Early | 16.9 | 8.5 | 16.0 |
| | S-137 | -do- | -do- | Middle | 16.5 | 8.6 | 16.3 |
| | S-138 | -do- | -do- | Late | 16.8 | 8.8 | 16.6 |
| 5 | S-197 | 320F | Barnala (Barnala) | Early | 20.6 | 4.8 | 19.5 |
| | S-199 | -do- | -do- | Middle | 20.0 | 4.4 | 18.8 |
| | S-198 | -do- | -do- | Late | 17.7 | 5.3 | 16.8 |
| 6. | S-200 | Desi | Barnala (Barnala) | Early | 18.7 | 5.4 | 17.8 |
| | S-230 | -do- | -do- | Middle | 19.0 | 10.8 | 19.2 |
| | S-201 | -do- | -do- | Late | 19.3 | 4.2 | 18.1 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 7. | S-179 | 35/1 Good Desi | Meerut (Meerut) | Early | 17.7 | 7.5 | 17.2 |
|  | S-180 | -do- | -do- | Middle | 17.9 | 7.6 | 16.6 |
|  | S-192 | -do- | -do- | Late | 18.1 | 4.7 | 17.1 |
| 8. | S-189 | Desi | Mathura (Mathura) | Early | 18.0 | 6.5 | 17.3 |
|  | S-190 | -do- | -do- | Middle | 18.3 | 6.6 | 17.6 |
|  | S-191 | -do- | -do- | Late | 17.3 | 6.2 | 16.6 |
| 9. | S-173 | Virnar | Sindkheda (West Khandesh) | Early | 19.1 | 6.5 | 18.4 |
|  | S-188 | -do- | -do- | Middle | 17.7 | 5.9 | 16.9 |
| 10. | S-176 | Virnar | Dharangaon (E. Khandesh) | Early | 19.4 | 5.7 | 18.5 |
|  | S-177 | -do- | -do- | Middle | 19.7 | 5.8 | 18.8 |
| 11. | S-186 | Virnar | Sawasa (E. Khandesh) | Early | 19.3 | 5.9 | 18.5 |
|  | S-187 | -do- | -do- | Middle | 18.3 | 5.8 | 17.5 |
| 12. | S-119 | Jayawant | Raichur (Raichur) | Early | 15.9 | 8.2 | 15.6 |
|  | S-121 | -do- | -do- | Middle | 15.7 | 7.3 | 15.2 |
| 13. | S-111 | Cambodia | Salem (Salem) | Early | 16.0 | 8.0 | 15.7 |
|  | S-149 | -do- | -do- | Middle | 16.0 | 11.4 | 16.5 |
| 14. | S-212 | Cambodia | Villupuram (S. Arcot) | Early | 18.3 | 12.4 | 18.8 |
|  | S-213 | -do- | -do- | Middle | 18.0 | 11.8 | 18.4 |
| 15. | S-151 | L. S. S. | Fazilka (Ferozpur) | Early | 22.1 | 8.8 | 21.8 |
|  | S-152 | -do- | -do- | Middle | 22.4 | 9.5 | 22.3 |
| 16. | S-153 | Malvi-9 | Manasa(Mandsaur) | Early | 17.4 | 10.6 | 17.5 |
|  | S-155 | -do- | -do- | Late | 19.0 | 9.9 | 19.0 |
| 17. | S-157 | Malvi-9 | Mandsaur (dt.) | Early | 19.2 | 11.2 | 19.5 |
|  | S-154 | -do- | -do- | Late | 17.7 | 11.8 | 18.1 |
| 18. | S-156 | Malvi-9 | Shamgarh (Mandsaur) | Early | 17.1 | 12.1 | 17.5 |
|  | S-158 | -do- | -do- | Late | 17.6 | 12.5 | 18.1 |
| 19. | S-161 | Cambodia | Feriyakulam (Madurai) | Early | 19.1 | 11.9 | 19.5 |
|  | S-162 | -do- | -do- | Late | 20.1 | 10.0 | 20.1 |
| 20. | S-163 | Madras Uganda I | -do- | Early | 16.1 | 9.6 | 16.0 |
|  | S-164 | -do- | -do- | Late | 20.0 | 10.7 | 20.2 |
| 21. | S-170 | Desi | Bulandshahr (Dt.) | Early | 19.4 | 7.3 | 18.8 |
|  | S-231 | -do- | -do- | Late | 15.5 | 10.9 | 15.7 |
| 22. | S-325 | Lakshmi | Adoni (Kurnool) | Middle | 16.9 | 5.7 | 16.1 |
|  | S-326 | -do- | -do- | Late | 18.2 | 9.3 | 18.1 |

Out of the first category of early, middle, and late harvesting picking samples, only one sample showed a regular increase in oil content with the advanced pickings, two samples have oil contents in the decreasing order and five have oil contents which do not give any definite indication. In the early and middle picking samples, two have shown increase in oil content in the later picking. In one of the oil content is practically the same and in four, the oil content decreased. The third category of early and late picking samples, however, gave a better indication. In four out of the six samples, there is an increase and in two there is a decrease in oil content with the advanced picking. In the solitary sample of middle and late harvesting, there is an increase in the oil content. From the above, it is felt that, while one might be tempted to draw the indication that probably the oil content slightly increases with the advanced picking, more data has to be obtained before any definite conclusion can be drawn in this matter.

From the data given in Table I and in the two previous papers it is found that the oil content of the same Desi or American variety of cottonseed produced in different localities of even the same and/or different States varies from each other to a fair extent. It is also found that the oil content of the same variety in the same locality also differs in the different seasons. For example, N 14-Northerns from Nandyal in Kurnool district had an oil content of 15.1% in the 1951-52 season sample, it had 17.6% in the 1952-53 sample and 15.8% in the 1953-54 sample. Hingari seed sampled from Tadpatri in Anantapur District contained 17.7% in 1951-52 and 15.7% in the 1952-53 sample—all on 10% moisture basis. As many factors such as location seasonal and weather conditions influence the variability in comparison of cottonseed, it is difficult to discuss one factor without including one or both of the other remaining factors. Therefore it is necessary to make further properly planned studies in this direction before any conclusions could be drawn. Work in this direction is taken on hand.

### Suitability of Desi Variety Seeds for Milling for Oil:

Another important observation that could be made from the data presented in this and in the previous papers is that while in general the oil content in American varieties in India are higher than in the Desi varieties, there are several desi varieties containing equal or even higher oil content than some of the American variety seeds, in almost all parts of the country. For instance, samples of Kakinadas and Mungari cottonseed in Andhra, Nadam and Uppam variety seeds in Madras, Virnar and Pratap seed in Bombay State, Gaorani 12 in Hyderabad State, Jarillas in Madhya Pradesh, Desi seed in Punjab, Doddahatti in Mysore and local Buris in Madhya Bharat all contain 18% and higher oil on 10% moisture basis which is higher than that of several Indian, American varieties in several regions. This is of importance as it shows that all these desi varieties of seed will be economical for crushing for the oil. This information, it is hoped would help to modify the view held by a very large section of the present cottonseed millers in India that only American variety seed will be economical for processing for the oil and the Desi variety for feeding the cattle only. It is all the more necessary to emphasise that several varieties of Desi seed in selected regions are quite suitable for oil milling, if it is remembered that during the years 1950-51 to 1953-54 as high as 88.1%, 85.0%, 81.7% and 76.6% respectively of the total production in India is of Desi varieties and the rest only of American varieties, i.e., for the above years (6), it is respectively 11.9%, 15%, 18.3% and 23.4%. It will therefore, be noted that the cottonseed milling industry cannot develop fully and the raw material cannot be exploited properly, if the crushing of cottonseed is confined to the American variety seeds only.

**Summary and Conclusions:**

1. Data on the composition of 120 samples of cottonseed drawn from 12 important cotton growing States of India is presented.

2. The previous conclusions (1, 2) regarding the composition and size of the Indian Cottonseed are confirmed by the additional data. From the data so far obtained, the average protein content of Indian cottonseed (both Desi and American variety) appears to be lower than that of the cottonseed, in America.

3. Among the Desi varieties of Indian Cottonseed "G. Arboreum" species cottonseeds have less of the lint (fuzz) than the "G. Herbaceum" species seeds. The "Arboreum" group Cottonseeds show a wider range of seed size and the "Herbaceum" species seeds are characterised by a greater uniformity in seed size than the "Arboreum" species Desi seeds.

4. The oil content of the same variety of cottonseed varies with different localities and different seasons even in the same locality.

5. No definite conclusion can be drawn as yet as to how the oil content varies with the maturity of the seed, as the data obtained on 22 samples of the same variety of cottonseed from the same locality (and State) obtained at different periods of picking does not give any definite indication. More data has to be obtained.

6. From the data on oil and lint contents obtained so far from 230 samples of Desi and American variety cottonseeds from 12 States over a period of 3 seasons it is found that, while the American variety seeds contain these to a higher extent, several Desi varieties produced in several States also contain 18% or over of oil and will be economical for processing for oil and not merely as a cattle feed.

Work on refining of cottonseed oil and on the pretreatment delinting, dehulling and milling of the seed on pilot plants is well under way and the results will be published shortly.

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4. Personal communication from the Cotton specialist, Coimbatore. dated 14-4-1949.

5. Bailey. A. E., **Cottonseed and Cottonseed Products**, New York Interscience, (Fats & Oils Series), (1948), p. 157.

6. Personal Communication from the Assistant Secretary, Indian Central Cotton Committee, Bombay, dated 25-8-54.

# "STUDIES ON THE COMPOSITION OF DIFFERENT VARIETIES OF GROUNDNUTS PRODUCED IN SOUTH INDIA—PART I".

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**The need and importance of the study of the composition of different varieties of groundnuts of South India for efficient milling stated. The analytical data of 180 representative samples of the main varieties of groundnuts produced in Andhra and Madras States and the protein content of 25 of these samples presented. The oil content is found to vary from 42.3% to 56.5%, moisture from 2.3% to 7.1%, the F.F.A. of the oil in the seeds from 0.07% to 6.0% and the shelling percentage from 18.1% to 33.9%. The oil contents of some of the samples are found to be the highest ever reported. The protein content varied from 21.0% to 32.1% with an average value of 25.0%. Average oil content of the peanut variety is found to be slightly higher than that of coromandel and TMV varieties while the average protein content of the T.M.Vs is found slightly higher than that of the other two varieties. From the oil contents and F.F.As (of the oil in the seeds) of the shelled and unshelled samples of the same variety from the same locality and source of 60 samples tested, no correlation seems to exist. Further laboratory and pilot plant work on the improvements in Oil Milling Processes is in progress.**

## Introduction:

The study on the composition of the different varieties of groundnuts produced in the Composite Madras State was undertaken in June 1952 as a preliminary study in the Research scheme of "Improvements in the Oil Milling Processes". The scope of this scheme is to study improvement as applied to the milling of the major oilseeds produced in the present Andhra and Madras States, namely, groundnuts, cottonseed, copra, sesamum and castorseeds. The most important of these oilseeds being groundnut, (the composite Madras State produced about half of the total groundnut production in India), it is taken up first.

For any studies to effect improvements in the prevailing oil milling processes of groundnuts, it is considered necessary to know the oil content of the groundnuts available for milling as well as the oil content left in the residual cake. It is also considered that a systematic study of the composition of the several varieties of groundnuts produced in all the important districts of these two States over 3 or 4 successive seasons will give data which will be very valuable for the industry in these States, in particular, and the country in general. It may be stated, in this connection, that such a systematic study on the composition of samples of groundnuts representing bulk production in the State is not done before and this data is not available so far in India, although in a number of agricultural research stations in various States analysis for oil content, etc., on the experimental samples of the research stations has been

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carried out but not on trade samples representing bulk production in the country. At any rate, this was not done in the Composite Madras State, to which region the present work is confined.

Hence, as a preliminary to the studies on the scheme, analytical work on the composition of the various varieties of groundnuts from different important groundnut producing districts of the Composite Madras State was commenced in June 1952. The first 16 samples were obtained from the trade (and mills) sources. Thereafter, representative samples drawn by the officials of the Agricultural Department of the Andhra and Madras States according to standard sampling methods were obtained. Samples were also obtained of the same variety of groundnut both from the rainfed and the irrigated crops and also of the same variety from the same locality in different (successive) seasons, wherever possible. As the varieties are given under different and somewhat confusing names, it is to be stated that the main varieties in Andhra and Madras States are (i) Coromandel (also termed spreading variety and sometimes as Mozambique or Mauritius), cultivated both irrigated and rainfed, is the largest variety produced to the extent of more than 80% of the total crop. (ii) Next in importance is the peanut variety, also called the bunch, Spanish or Khandesh variety. It is produced mainly in Guntur, Krishna, Cuddapah, Kurnool, North Arcot and Salem. This variety is also cultivated both as rainfed and irrigated crop and is over 10% of the total production. (iii) A third variety is called Pollachi Red also known as Red Natal, small Japan or Lal Boria (in Bombay). It is a bunch variety and is localised mainly in Pollachi taluka in Coimbatore district and parts of Madurai district. This represents only about 3% of the total production and is grown as a rainfed crop. (iv) Besides these bulk varieties, improved types like TMV-1, TMV-2 and TMV-3 developed by the Agricultural Department at Tindivanam are also becoming popular and produced on a large scale in the two States. The above information is given in order to enable the reader to follow the analytical data furnished later in this paper.

**Experimental:**

In all 180 representative samples obtained as stated earlier have been analysed to date for moisture and oil content of the kernels and F.F.A. of the oil in the kernels. Protein contents of 25 selected samples from 1953-54 season have also been determined. The American Oil Chemists' Society Methods have been followed in all the experimental work, with slight modifications wherever found necessary. All experiments are done in duplicate and the mean values taken. Both unshelled and shelled groundnut samples for each variety have been obtained and the analysis on the kernels (shelled nuts) in both cases is done. The oil content of groundnut kernels is also given on a 5% moisture basis for purposes of comparison, since the moisture variation in groundnuts is usually within the limits of 5.0+or—2.5 per cent. The analytical data on 180 samples is given in Table I below.

The protein contents of 25 samples of seeds are given in Table II.

**TABLE I**

**Giving data on the analysis of Groundnuts of**

| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| | | | **1951-52.** | **ANDHRA** |
| 1. | S-1 | Coromandel (Unshelled) | | Local (Anantapur) |
| 2. | S-2 | — do — (Shelled) | | — do — |
| 3. | S-9 | — do — | | Uravakonda (Anantapur) |
| 4. | S-10 | — do — (Unshelled) | | Gooty (Anantapur) |
| 5. | S-11 | Coromandel (Shelled) | | — do — |
| 6. | S-12 | Coromandel (Unshelled) | | Kudligi-Harpanahalli (Bellary) |
| 7. | S-13 | — do — (Shelled) | | — do — |
| 8. | S-16 | — do — (Unshelled) | | Guntakal (Anantapur) |
| 9. | S-3 | Peanuts (Unshelled) | | Hagari-Bommanahalli (Bellary) |
| 10. | S-4 | — do — (— do —) | | — do — |
| 11. | S-14 | Khandesh Peanuts (Unshelled) | | Kudligi-Harpanahalli (Bellary) |
| 12. | S-15 | — do — (Shelled) | | — do — |
| | | | **1951-52.** | **MADRAS** |
| 13. | S-5 | "Nadu" Coromandel Rainfed (Unshelled) | Dec. '51. | Melur (Madurai) |
| 14. | S-6 | — do — (Shelled) | — do — | — do — |
| 15. | S-7 | Not known (Unshelled) (Probably Peanut) | Nov. '51. | Polur (N. Arcot) |
| 16. | S-8 | "Nadu" Coromandel (Rainfed) (Shelled) | — do — | — do — |
| | | | **1952-53.** | **ANDHRA** |
| 17. | S-35 | Coromandel (Unshelled) (Rainfed) | | Proddutur (Cuddapah) |
| 18. | S-36 | ,, (Shelled) — do — | | — do — |
| 19. | S-37 | ,, (Unshelled) — do — | Middle | — do — |
| 20. | S-38 | ,, (Shelled) — do — | — do — | — do — |
| 21. | S-39 | ,, (Unshelled) | End | — do — |
| 22. | S-40 | ,, (Shelled) | — do — | — do — |
| 23. | S-49 | ,, (Unshelled) | — | Vizianagaram (Vizag) |
| 24. | S-50 | ,, (Shelled) | — | — do — |
| 25. | S-55 | ,, (Unshelled) — do — | Nov.-Dec. '52 | Gooty-Anantapur |
| 26. | S-56 | ,, (Shelled) — do — | — | — do — |

different varieties and seasons from Andhra and Madras States.

| Moisture per cent. | Oil content on the moisture basis in the sample. | Oil content calculated on 5% moisture basis. Per cent. | F.F.A. of the oil in the sample. Per cent. | Shell—in percentage. |
|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 |
| **STATE AREA.** | | | | |
| 4.7 | 49.9 | 49.7 | 1.3 | — |
| — | — | — | — | — |
| 6.5 | 50.5 | 51.3 | 0.7 | — |
| 5.3 | 53.5 | 53.7 | 0.8 | — |
| 5.5 | 52.2 | 52.8 | 1.0 | — |
| 6.2 | 54.3 | 55.0 | 0.4 | — |
| 6.2 | 53.6 | 54.3 | 0.9 | — |
| 5.2 | 52.7 | 53.0 | 0.4 | — |
| 6.5 | 53.3 | 54.1 | — | — |
| 6.0 | 52.9 | 53.5 | — | — |
| 6.6 | 50.8 | 51.5 | 0.5 | — |
| 5.8 | 51.1 | 51.5 | 1.0 | — |
| **STATE AREA** | | | | |
| 5.6 | 54.9 | 55.2 | 0.7 | — |
| 6.0 | 55.5 | 56.1 | 1.9 | — |
| 4.6 | 54.7 | 54.5 | 0.6 | — |
| 6.7 | 53.4 | 54.4 | 0.5 | — |
| **STATE AREA** | | | | |
| 3.9 | 48.7 | 48.1 | 0.22 | — |
| 3.8 | 47.0 | 46.4 | 0.28 | — |
| 4.4 | 49.8 | 49.5 | 0.55 | — |
| 4.3 | 51.3 | 50.9 | 0.21 | — |
| 4.2 | 51.6 | 51.2 | 0.28 | — |
| 4.3 | 49.8 | 49.4 | 0.29 | — |
| 3.4 | 50.9 | 50.1 | 0.8 | 30.4 |
| 3.7 | 53.1 | 52.4 | 0.7 | — |
| 4.3 | 52.4 | 52.0 | 0.9 | 26.3 |
| 6.1 | 50.8 | 51.4 | 6.0 | — |

TABLE I

| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 27. | S-60 | ,, (Unshelled) | ——— | Kurnool (Dt.) |
| 28. | S-64 | ,, (Shelled) (— do —) | Early | Alur (Kurnool) |
| 29. | S-65A | ,, (— do —) (— do —) | Late | — do — |
| 30. | S-66 | ,, (— do —) (— do —) | Middle | — do — |
| 31. | S-76 | ,, (Unshelled) (— do —) | Dec. '52 | Tadpatri (Anantapur) |
| 32. | S-77 | ,, (Shelled) (— do — | — do — | — do — |
| 33. | S-17 | Peanuts (Unshelled) (Rainfed) | Oct. '52 Early | Adoni (Kurnool) |
| 34. | S-18 | ,, (Shelled) (— do —) | ,, Middle | — do — |
| 35. | S-19 | ,, (Unshelled) (— do —) | ,, Early | — do — |
| 36. | S-20 | ,, (— do —) (— do —) | ,, Middle | — do — |
| 37. | S-23 | ,, (— do —) (— do —) | Oct. '52 | Guntur (Guntur) |
| 38. | S-24 | ,, (Shelled) | — do — | — do — |
| 39. | S-27 | ,, (Unshelled) | ——— | Gannavaram (Krishna) |
| 40. | S-28 | ,, (Shelled) | ——— | — do — |
| 41. | S-31 | ,, (Unshelled) | ——— | Vayalpad (Chittoor) |
| 42. | S-32 | ,, (Shelled) | ——— | —do— |
| 43. | S-41 | ,, (Unshelled) | Early | Proddutur (Cuddapah) |
| 44. | S-42 | ,, (—do—) (Rainfed) | Early | —do— |
| 45. | S-43 | ,, (—do—) (— do —) | Middle | —do— |
| 46. | S-44 | ,, (Shelled) (— do —) | Middle | —do— |
| 47. | S-45 | ,, (Unshelled) (— do —) | Late | —do— |
| 48. | S-46 | ,, (Shelled) (— do —) | —do— | —do— |
| 49. | S-47 | ,, (Unshelled) (— do —) | End | —do— |
| 50. | S-48 | ,, (Shelled) (Irrigated) | End | —do— |
| 51. | S-59 | ,, (Unshelled) | ——— | Kurnool |
| 52. | S-63 | ,, (Shelled) (Rainfed) | Late | Alur (Kurnool) |
| 53.@ | S-78 | ,, (—do—) (— do —) | Early | Proddutur (Cuddapah) |
| 54. | S-79 | ,, (Unshelled) (— do —) | Early | —do— |
| 55.@ | S-80 | ,, (Shelled) (— do —) | Middle | —do— |
| 56. | S-81 | ,, (Unshelled) (— do —) | —do— | —do— |
| 57.@ | S-82 | ,, (Shelled) (— do —) | Late | —do— |
| 58. | S-83 | ,, (— do —) (— do —) | —do— | —do— |
| 59. | S-88 | ,, — do — ) (— do —) | Early | Bezwada (Krishna) |
| 60. | S-25 | TMV-2 (Unshelled) | ——— | Gannavaram (Krishna) |
| 61. | S-26 | ,, (Shelled) | ——— | —do— |
| 62. | S-29 | TMV-3 (Unshelled) | Early | Vayalpad (Chittoor) |
| 63. | S-30 | ,, (Shelled) | ——— | —do— |
| 64. | S-57 | TMV-2 (Unshelled) (Rainfed) | Nov. 52 | Gurazala (Guntur) |
| 65. | S-58 | ,, (Shelled) (— do —) | —do— | —do— |
|  |  |  | **1952-53** | **MADRAS** |
| 66. | S-51 | Coromandel (Unshelled) (Rainfed) | Nov. 52 | Wandiwash (N. Arcot) |
| 67. | S-67 | ,, (— do —) (—do—) | Late | Srivilliputhur (Ramnad) |

(Continued)

| Moisture per cent. 6 | Oil content on the moisture basis in the sample. 7 | Oil content calculated on 5% moisture basis. Per cent. 8 | F.F.A. of the oil in the sample. Per cent. 9 | Shell—in percentage. 10 |
|---|---|---|---|---|
| 5.5 | 50.1 | 50.4 | 0.78 | 23.5 |
| — | 50.7 | — | 0.41 | — |
| 5.2 | 52.6 | 52.7 | — | — |
| 5.6 | 50.4 | 50.8 | — | — |
| 5.1 | 45.2 | 45.2 | 1.9 | 28.7 |
| 5.7 | 46.0 | 46.3 | 4.6 | — |
| 4.0 | 52.1 | 51.5 | 0.7 | — |
| 4.1 | 50.9 | 50.4 | 0.4 | — |
| 4.0 | 50.2 | 49.7 | 0.6 | — |
| 4.4 | 49.9 | 49.6 | 0.5 | — |
| 5.7 | 51.1 | 51.5 | 1.1 | — |
| 5.8 | 52.2 | 52.6 | 0.6 | — |
| 6.1 | 51.0 | 51.8 | 0.2 | — |
| 5.1 | 51.6 | 51.7 | 0.2 | — |
| 4.7 | 45.8 | 45.6 | 0.27 | — |
| 4.4 | 50.2 | 49.9 | 0.52 | — |
| 4.1 | 51.6 | 51.1 | 0.68 | 33.4 |
| 4.3 | 50.4 | 50.2 | 0.78 | — |
| 4.5 | 50.0 | 50.3 | 1.1 | 33.1 |
| 4.1 | 49.9 | 49.4 | 1.2 | — |
| 4.1 | 49.5 | 49.0 | 1.1 | 33.5 |
| 4.1 | 49.6 | 49.1 | 1.6 | — |
| 3.6 | 50.6 | 49.9 | 0.8 | 32.3 |
| 4.0 | 50.3 | 49.8 | 0.70 | — |
| 4.1 | 52.7 | 52.2 | 0.78 | 23.5 |
| 5.9 | 51.9 | 52.7 | 0.20 | — |
| 6.7 | 51.2 | 52.1 | 10.4 @ | — |
| 6.3 | 50.4 | 51.1 | 3.7 | 26.0 |
| 6.1 | 52.1 | 52.7 | 11.0 @ | — |
| 5.5 | 51.9 | 52.2 | 2.8 | 27.2 |
| 6.6 | 50.7 | 51.6 | 9.2 @ | — |
| 5.8 | 50.5 | 50.9 | 0.35 | 28.6 |
| 4.5 | 49.3 | 49.0 | 1.7 | — |
| 6.1 | 51.0 | 51.6 | 0.20 | — |
| 5.2 | 49.8 | 49.9 | 0.14 | — |
| 4.4 | 49.0 | 48.7 | 0.35 | — |
| 4.6 | 47.1 | 47.7 | 0.22 | — |
| 4.8 | 52.6 | 52.5 | 0.25 | — |
| 4.4 | 42.3 | 42.0 | 0.43 | — |
| STATE AREA: | | | | |
| 5.6 | 49.5 | 49.8 | 1.1 | 25.7 |
| 4.9 | 45.1 | 45.0 | 0.27 | — |

| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 68. | S-71A | ,, (Unshelled) (Irrigated) | July 53 | Tindivanam (S. Arcot) |
| 69. | S-71B | ,, (— do —) (Rainfed) | Late | Srivilliputhur (Ramnad) |
| 70. | S-72 | ,, (—do—) (Irrigated) | July 53 | Tindivanam (S. Arcot) |
| 71. | S-75 | ,, (Shelled) (— do —) | June 53 | —do— |
| 72. | S-84 | ,, (—do—) (— do —) | Early Sep. 53 | Karur (Trichi) |
| 73. | S-85 | ,, (—do—) (— do —) | — do — | —do— |
| 74. | S-86 | ,, (Unshelled) (— do —) | — do — | —do— |
| 75. | S-87 | ,, (Shelled) (— do —) | — do — | —do— |
| 76. | S-155 | ,, (Unshelled) (— do —) | August 53 | Omalur (Salem) |
| 77. | S-156 | ,, (Shelled) (— do —) | — do — | —do— |
| 78. | S-157 | ,, (Unshelled) (— do —) | Aug.-Sep. 53 | —do— |
| 79. | S-158 | ,, (Shelled) (Rainted) | — do — | —do— |
| *80. | S-65B | Peanuts (Unshelled) (— do —) | Late harvest | Srivilliputhur (Ramnad) |
| 81. | S-159 | ,, (—do—) (— do —) | Aug.-Sep. 52 | Mechur (Salem) |
| *82. | S-160 | ,, (Shelled) (— do —) | — do — | —do— |
| 83. | S-21 | TMV-1 (Unshelled) (Irrigated) | Oct. 52 | Karur (Trichi) |
| 84. | S-22 | ,, (Shelled) (— do —) | — do — | —do— |
| 85. | S-33 | ,, (Unshelled) (— do —) | —— | Dindigal (Dt.) |
| 86. | S-34 | ,, (—do—) | —— | —do— |
| 87. | S-53 | TMV-1 (—do—) (Rainfed) | Nov.-Dec. 52 | Mettur (Salem) |
| 88. | S-54 | ,, (Shelled) (— do —) | —— | —do— |
| 89. | S-61 | TMV-3 (Unshelled) (— do —) | —— | Tindivanam (S. Arcot) |
| 90. | S-62 | ,, (Shelled) (— do —) | —— | —do— |
| 91. | S-68 | TMV-2 (Unshelled) (— do —) | Late | Srivilliputhur (Ramnad) |
| 92. | S-69 | TMV-1 (—do—) (— do —) | — do — | —do— |
| 93. | S-70 | TMV-3 (—do—) | — do — | —do— |
| 94. | S-73 | TMV-4 (—do—) | —— | Villupuram |
| 95. | S-74 | " (—do—) | —— | — do — |
| | | | **1953-54** | **ANDHRA** |
| 96. | S-89 | Coromandel (Shelled) (Rainfed) | Nov. 53 | Tiruttani (Chittoor) |
| 97. | S-96 | ,, (—do—) (— do —) | Dec. 53 | Anantapur |
| 98. | S-97 | ,, (Unshelled) (— do —) | Oct. 53 | Vizainagaram (Vizag.) |
| 99. | S-98 | ,, (Shelled) (— do —) | — do — | Vizainagaram |
| 100. | S-102 | ,, (Unshelled) (— do —) | Late Nov. 53 | Gargefapuram (Kurnool) |
| 101. | S-104 | ,, (Shelled) (— do —) | Nov.-Dec. 53 | Anantapur |
| 102. | S-105 | ,, (Unshelled) (— do —) | Aug.-Sept. 53 | Uttamapalayam taluk |
| 103. | S-106 | ,, (Shelled) (— do —) | — do — | —do— |
| 104. | S-128 | ,, (Unshelled) (— do —) | Dec. 53 | Alur (Kurnool) |
| 105. | S-129 | ,, (Shelled) (— do —) | — do — | —do— |
| 106. | S-134 | ,, (—do—) (— do —) | ——— | Hindupur (Anantapur) |
| 107. | S-135 | ,, (Unshelled) (— do —) | Nov.-Dec. 53 | Gooty (—do—) |
| 108. | S-136 | ,, (Shelled) (— do —) | — do — | —do— |

(Continued)

| Moisture per cent. | Oil content on the moisture basis in the sample. | Oil content calculated on 5% moisture basis. Per cent. | F.F.A. of the oil in the sample. Per cent. | Shell—In percentage. |
|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 |
| 4.1 | 51.0 | 50.5 | 0.32 | 26.6 |
| 5.3 | 47.2 | 47.0 | — | 25.5 |
| 4.7 | 54.4 | 54.2 | 0.43 | — |
| 5.8 | 53.4 | 53.5 | 0.81 | — |
| 6.4 | 50.4 | 51.2 | 0.40 | — |
| 6.3 | 51.3 | 52.0 | 2.7 | — |
| 5.6 | 48.8 | 49.1 | 3.5 | — |
| 5.8 | 49.8 | 50.2 | 0.12 | — |
| 4.1 | 51.3 | 50.8 | 0.21 | 25.6 |
| 4.2 | 51.5 | 51.0 | 0.24 | — |
| 4.3 | 51.2 | 50.8 | 0.16 | 25.4 |
| 4.2 | 52.2 | 51.8 | 0.13 | — |
| 5.4 | — | — | — | 25.4 |
| 4.3 | 50.6 | 50.2 | 0.14 | 25.2 |
| — | — | — | — | — |
| 5.3 | 50.1 | 50.2 | 0.30 | — |
| 7.1 | 50.9 | 50.5 | 0.20 | — |
| 4.2 | 51.2 | 50.8 | 0.37 | 30.0 |
| 4.0 | 51.7 | 51.2 | 0.37 | — |
| 4.7 | 51.4 | 51.2 | 0.36 | — |
| 4.6 | 48.3 | 48.1 | 0.50 | — |
| 5.3 | 45.7 | 45.8 | 0.21 | — |
| 5.3 | 45.9 | 46.0 | 0.35 | — |
| 5.0 | 47.2 | 47.2 | 0.30 | 24.3 |
| 5.9 | 50.2 | 50.6 | 0.34 | — |
| 4.8 | 50.8 | 50.7 | 0.20 | 25.3 |
| 5.3 | 54.5 | 54.7 | 0.14 | — |
| 5.1 | 50.0 | 50.0 | 0.91 | 21.2 |
| STATE | | | | |
| 5.1 | 46.6 | 46.7 | 0.13 | — |
| 5.3 | 47.4 | 47.6 | 0.11 | — |
| 5.4 | 50.3 | 50.5 | 0.07 | 33.9 |
| 5.0 | 50.8 | 50.8 | — | — |
| 4.1 | 54.3 | 53.8 | 1.0 | — |
| 4.0 | 52.2 | 51.7 | 0.56 | — |
| 4.5 | 46.6 | 46.4 | 1.1 | 23.1 |
| 4.6 | 47.7 | 47.5 | 0.47 | — |
| 3.9 | 49.6 | 49.0 | 0.24 | 23.3 |
| 3.8 | 53.2 | 52.5 | 1.8 | — |
| 4.0 | 51.5 | 50.9 | 1.9 | — |
| 4.2 | 50.0 | 49.6 | 1.3 | 22.9 |
| 4.2 | 51.6 | 51.3 | 0.13 | — |

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| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 109. | S-139 | ,, (Unshelled) (— do —) | Late Nov. 53 | Hampapuram (Anantapur) |
| 110. | S-140 | ,, (Shelled) (— do —) | —do— | —do— |
| 111. | S-143 | ,, (Unshelled) (— do —) | Early Oct. 53 | Korrapad (Cuddapah) |
| 112. | S-144 | ,, (Shelled) (— do —) | —do— | —do— |
| 113. | S-145 | ,, (Unshelled) (— do —) | Middle Oct. 53 | —do— |
| 114. | S-146 | ,, (Shelled) (— do —) | —do— | —do— |
| 115. | S-147 | ,, (Unshelled) (— do —) | Late Nov. 53 | —do— |
| 116. | S-148 | ,, (Shelled) (— do —) | —do— | —do— |
| 117. | S-163 | ,, (Unshelled) (— do —) | Nov. 53 | Narasaraopet (Guntur) |
| 118. | S-164 | ,, (Shelled) (— do —) | —do— | —do— |
| 119. | S-165 | ,, (—do—) (— do —) | —do— | Bhimunipatnam (Vizag.) |
| 120. | S-166 | ,, (Unshelled) (— do —) | —do— | Ongole-Guntur |
| 121. | S-167 | ,, (Shelled) (— do —) | —do— | —do— |
| 122. | S-168 | ,, (Unshelled) (— do —) | Dec. 53 | Tadpatri (Anantapur) |
| 123. | S-169 | ,, (Shelled) (— do —) | —do— | —do— |
| 124. | S-184 | ,, (Unshelled) (— do —) | ———— | Bellary |
| 125. | S-94 | Peanuts (Shelled) (— do —) | ———— | Cuddapah |
| 126. | S-100 | ,, (Unshelled) (— do —) | Late Oct. 53 | Sattenapalle Atchempeta (Guntur) |
| 127. | S-101 | ,, (— do —) (— do —) | —do— | Gargeyapuram (Kurnool) |
| 128. | S-107 | ,, (Shelled) (— do —) | —do— | Atchempeta (Guntur) |
| 129. | S-114 | ,, (Unshelled) (— do —) | Early Oct. 53 | Gurazala-Palnad (Guntur) |
| 130. | S-115 | ,, (Shelled) (— do —) | —do— | —do— |
| 131. | S-116 | ,, (Unshelled) (— do —) | Middle Oct. 53 | —do— |
| 132. | S-117 | ,, (Shelled) (— do —) | —do— | —do— |
| 133. | S-118 | ,, (Unshelled) (— do —) | Late Nov. 53 | —do— |
| 134. | S-119 | ,, (Shelled) (— do —) | —do— | —do— |
| 135. | S-120 | ,, (Unshelled) (— do —) | Mid. Feb. 54 | Karlapalem (Guntur) |
| 136. | S-121 | ,, (Shelled) (— do —) | —do— | —do— |
| 137. | S-126 | ,, (Unshelled) (————) | Oct.-Nov. 53 | Gannavaram (Krishna) |
| 138. | S-127 | ,, (Shelled) (————) | —do— | —do— |
| 139. | S-130 | ,, (Unshelled) (— do —) | Mid. Oct. 53 | Alur (Kurnool) |
| 140. | S-131 | ,, (Shelled) (— do —) | —do— | —do— |
| 141. | S-149 | ,, (Unshelled) (— do —) | Early Oct. 53 | Proddutur (Cuddapah) |
| 142. | S-150 | ,, (Shelled) (— do —) | —do— | —do— |
| 143. | S-151 | ,, (Unshelled) (— do —) | Mid. Oct. 53 | —do— |
| 144. | S-152 | ,, (Shelled) (— do —) | —do— | —do— |
| 145. | S-153 | ,, (Unshelled) (— do —) | Late Nov. 53 | —do— |
| 146. | S-154 | ,, (Shelled) (— do —) | —do— | —do— |
| 147. | S-161 | ,, (Unshelled) (— do —) | Oct. 53 | Narasaraopet (Guntur) |
| 148. | S-162 | ,, (Shelled) (— do —) | —do— | —do— |
| 149. | S-182 | ,, (Unshelled) (— do —) | —do— | Guntur Tq. |

(Continued)

| Moisture per cent.<br>6 | Oil content on the moisture basis in the sample.<br>7 | Oil content calculated on 5% moisture basis. Per cent.<br>8 | F.F.A. of the oil in the sample. Per cent.<br>9 | Shell—in percentage.<br>10 |
|---|---|---|---|---|
| 4.0 | 49.5 | 49.0 | 0.18 | 24.9 |
| 3.6 | 49.9 | 49.2 | 0.13 | — |
| 3.5 | 50.3 | 49.5 | 0.45 | — |
| 4.1 | 51.2 | 50.3 | 0.18 | — |
| 4.4 | 51.3 | 51.0 | 0.28 | 27.1 |
| 3.8 | 51.0 | 50.3 | 0.17 | — |
| 4.2 | 51.2 | 50.2 | 0.22 | 22.7 |
| 3.9 | 52.2 | 51.5 | 0.16 | — |
| 3.9 | 49.7 | 49.0 | 0.14 | 28.9 |
| 3.9 | 50.0 | 49.3 | 0.19 | — |
| 3.9 | 52.8 | 52.2 | 0.74 | — |
| 4.2 | 50.0 | 49.6 | 0.23 | 26.9 |
| 4.5 | 50.4 | 50.1 | 0.57 | — |
| 4.3 | 49.7 | 49.3 | 0.12 | 27.1 |
| 4.0 | 51.2 | 50.6 | 0.14 | — |
| 4.3 | 50.0 | 49.4 | 0.35 | 24.4 |
| 6.3 | 44.4 | 45.0 | 3.9 | — |
| | | | | |
| 5.0 | 51.9 | 51.9 | 0.26 | 24.1 |
| 4.4 | 55.9 | 55.5 | 0.26 | 23.9 |
| 4.9 | 52.7 | 52.7 | 0.9 | — |
| | | | | |
| 3.8 | 52.9 | 52.2 | 0.23 | 30.5 |
| 3.4 | 53.6 | 52.7 | 0.44 | — |
| 3.8 | 53.8 | 53.1 | 1.26 | 32.3 |
| 3.6 | 52.9 | 52.2 | 0.15 | — |
| 3.5 | 53.4 | 52.5 | 0.34 | 29.9 |
| 3.7 | 53.5 | 52.8 | 0.37 | — |
| 6.5 | 44.9 | 45.6 | 0.28 | 26.6 |
| 5.2 | 43.9 | 44.0 | 0.19 | — |
| 3.2 | 54.0 | 53.0 | 2.9 | 23.0 |
| 3.6 | 55.2 | 54.5 | 2.3 | — |
| 3.9 | 53.0 | 52.4 | 0.15 | 23.4 |
| 4.1 | 50.6 | 50.2 | 0.30 | — |
| 4.1 | 49.5 | 49.0 | 0.13 | 23.9 |
| 4.5 | 49.4 | 49.2 | 0.11 | — |
| 4.2 | 48.3 | 47.9 | 0.12 | 24.5 |
| 4.0 | 48.3 | 47.8 | 0.17 | — |
| 4.4 | 47.9 | 47.6 | 0.13 | — |
| 4.0 | 47.0 | 46.5 | 0.14 | — |
| 4.1 | 50.4 | 49.9 | 0.23 | 26.2 |
| 3.8 | 52.8 | 52.2 | 0.34 | — |
| 4.1 | 46.3 | 45.9 | 0.17 | 27.8 |

| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 150. | S-183 | ,, (Shelled) (—do—) | —do— | —do— |
| 151. | S-103 | TMV-2 (Unshelled) (————) | Sept. 53 | Gannavaram (Krishna) |
| 152. | S-132 | TMV-3 (—do—) (—do—) | Dec. 53 | Alur (Kurnool) |
| 153. | S-133 | ,, (Shelled) (—do—) | —do— | —do— |
| 154. | S-137 | ,, (Unshelled) (————) | Nov.-Dec. 53 | Gooty (Anantapur) |
| 155. | S-138 | ,, (Shelled) (————) | —do— | —do— |
| 156. | S-141 | ,, (Unshelled) (—do—) | Nov. 53 | Hampapuram (Anantapur) |
| 157. | S-142 | ,, (Shelled) (— do —) | —do— | —do— |
| 158. | S-170 | ,, (Unshelled) (— do —) | Dec. 53 | Tadpatri (Anantapur) |
| 159. | S-171 | ,, (Shelled) (—do—) | —do— | —do— |
| 160. | S-174 | ,, (Unshelled) | —do— | Vayalpad (Chittoor) |
| 161. | S-175 | ,, (Shelled) (————) | —do— | —do— |

**1953-54** **MADRAS**

| Serial No. | Sample No. | Variety (& irrigated or rainfed) | Harvesting season. | Locality and district. |
|---|---|---|---|---|
| 162. | S-90 | Coromandel (Unshelled) (Irrigated) | Oct. 53 | Karur (Trichi) |
| 163. | S-91 | ,, (Shelled) ( —do— ) | — do — | — do — |
| 164. | S-108 | ,, (Unshelled) (Rainfed) | Dec. 53 | Tidivanam (S. Arcot) |
| 165. | S-109 | ,, (Shelled) ( — do — ) | — do — | — do — |
| 166. | S-112 | ,, (Unshelled) ( — do — ) | Oct. 53 | Kandampatti (Salem) |
| 167. | S-113 | ,, (Shelled) ( — do — ) | — do — | — do — |
| 168. | S-125 | ,, (Unshelled) (— do —) | Mid-Oct. '53. | Srivilliputhur (Ramnad) |
| 169. | S-110 | TMV-3 (Unshelled) ( — do — ) | Dec. 53 | Tindivanam (S. Arcot) |
| 170. | S-111 | ,, (Shelled) ( — do — ) | — do — | — do — |
| 171. | S-122 | TMV-1 (Unshelled) ( — do — ) | Mid. Oct.53 | Srivilliputhur (Ramnad) |
| 172. | S-123 | ,, (Shelled) ( — do — ) | — do — | — do — |
| 173. | S-124 | TMV-2 (—do—) ( — do — ) | — do — | — do — |
| 174. | S-176 | TMV-1 (—do—) ( — do — ) | Oct. 53 | Pollachi (Coimbatore) |
| 175. | S-177 | ,, (Unshelled) ( — do — ) | — do — | — do — |
| 176. | S-178 | TMV-3 (—do—) ( — do — ) | Sep. 53 | — do — |
| 177. | S-179 | ,, (Shelled) ( — do — ) | — do — | — do — |
| 178. | S-180 | Pollachi Red (Unshelled) (—do—) | Aug. 53 | — do — |
| 179. | S-181 | ,, (Shelled) | — do — | — do — |
| 180. | S-92 | Local Akin to TMV-1 (Unshelled) | Late Oct. 53 | Karur (Trichi) |

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*Vide "Discussion of the Results"

@ Samples got damaged and wet in transit

(Continued)

| Moisture per cent. 6 | Oil content on the moisture basis in the sample. 7 | Oil content calculated on 5% moisture basis. Per cent. 8 | F.F.A. of the oil in the sample. Per cent. 9 | Shell—in percentage. 10 |
|---|---|---|---|---|
| 4.5 | 51.5 | 51.2 | 0.16 | — |
| 3.9 | 56.5 | 55.8 | 1.8 | 23.1 |
| 3.9 | 50.8 | 50.2 | 0.9 | 24.6 |
| 3.7 | 50.0 | 49.3 | 1.8 | — |
| 4.0 | 50.8 | 50.3 | 1.6 | 25.3 |
| 4.1 | 50.7 | 50.2 | 0.3 | — |
| 4.0 | 49.6 | 49.1 | 0.15 | 27.5 |
| 3.5 | 50.5 | 49.8 | 0.28 | — |
| 3.9 | 50.1 | 49.4 | 0.26 | 25.3 |
| 4.0 | 50.7 | 50.2 | 0.33 | — |
| 5.0 | 48.9 | 48.9 | 0.17 | 25.0 |
| 4.6 | 51.4 | 51.2 | 0.85 | — |
| STATE | | | | |
| 4.9 | 47.4 | 47.3 | 0.56 | 22.7 |
| 5.6 | 47.3 | 47.6 | 0.62 | — |
| 4.4 | 48.8 | 48.5 | 0.23 | 23.4 |
| 5.8 | 47.6 | 48.0 | 0.21 | — |
| 4.1 | 55.8 | 55.3 | 0.23 | 26.1 |
| 3.8 | 52.8 | 52.1 | 0.22 | — |
| 3.7 | 48.5 | 47.9 | 0.39 | 27.1 |
| 4.5 | 48.4 | 48.1 | 0.47 | — |
| 4.2 | 48.2 | 47.8 | 0.34 | — |
| 3.9 | 50.4 | 50.5 | 0.18 | 28.3 |
| 3.7 | 48.7 | 48.0 | 0.14 | 21.1 |
| 3.9 | 48.5 | 47.9 | 0.10 | 24.2 |
| 5.1 | 49.1 | 49.2 | 0.25 | 27.3 |
| 5.7 | 48.8 | 49.2 | 0.25 | — |
| 6.4 | 46.7 | 47.4 | 0.32 | 28.1 |
| 2.3 | 48.0 | 46.9 | 0.26 | — |
| 6.2 | 48.7 | 49.3 | 0.23 | 18.1 |
| 4.6 | 44.5 | 44.3 | 0.17 | 27.8 |
| 5.0 | 48.5 | 48.5 | 0.80 | 23.0 |

## TABLE II

**Protein contents of different varieties of Groundnuts produced in Andhra and Madras States during the 1953-54 harvesting season**

| Serial No. | Sample No. | Variety | Locality and District | Harvesting period | Protein per cent |
|---|---|---|---|---|---|
| 1. | S109 | Coromandal (Local Mauritius) | Molasur Village (Tindivanam) S. Arcot | Dec. 53 | 26.8 |
| 2. | S157 | Spreading variety (Coromandal) | Omalur (Salem) | Aug. Sept. 53 | 21.8 |
| 3. | S145 | Spreading variety | Kornapad (Cuddapah) | Oct. 53 | 25.2 |
| 4. | S146 | — do — | — do — | — do — | 25.0 |
| 5. | S135 | — do — | Gooty (Anantapur) | Nov. Dec. 53 | 26.0 |
| 6. | S129 | — do — | Alur (Kurnool) | Dec. 53 | 22.3 |
| 7. | S101 | Bunch (Peanut) | Gargeyapuram (Kurnool) | Oct. 53 | 22.1 |
| 8. | S120 | Local Bunch | Karlapalem (Guntur) | Feb. 54 | 32.1 |
| 9. | S159 | Bunch | Mechur (Salem) | Aug. Sept. 53 | 23.5 |
| 10. | S161 | — do — | Narasaraopet (Guntur) | Oct. 53 | 21.8 |
| 11. | S183 | Local Bunch | Guntur | — do — | 24.9 |
| 12. | S151 | Bunch | Tondaladinne (Cuddapah) | — do — | 25.2 |
| 13. | S119 | — do — | Gurazala-Palnad (Guntur) | Nov. 53 | 21.0 |
| 14. | S154 | — do — | Produttur (Cuddapah) | — do — | 25.8 |
| 15. | S103 | T.M.V.2 | Ganavaram (Krishna Dt.) | Sept. 53 | 23.6 |
| 16. | S123 | T.M.V.2 Dept. strain (Bunch type) farm produce. | Zonal Nucleus Seed Farm Srivilliputhur (Ramnad) | Middle | 26.5 |
| 17. | S124 | — do — | — do — | — do — | 28.4 |
| 18. | S137 | T.M.V.3 | Gooty (Anantapur) | Nov. Dec. 53 | 28.8 |
| 19. | S116 | T.M.V.2 | Gurazala-Palnad (Guntur) | Oct. 53 | 21.3 |
| 20. | S142 | T.M.V.3 | Hampapuram (Anantapur) | Nov. 53 | 26.8 |
| 21. | S133 | — do — | Dhanapuram (Kurnool Dt). | Dec. 53 | 29.6 |
| 22. | S175 | — do — | Vayalpad (Chittor) | — do — | 23.8 |
| 23. | S176 | T.M.V.1 | Pollachi (Coimbatore) | Nov. 53 | 24.1 |
| 24. | S181 | Pollachi Red (Local) | — do — | August. 53 | 22.6 |
| 25. | S139 | Local (Teega Sanaga) | Hampapuram (Anantapur) | Nov. 53 | 25.2 |

**Note:** The moisture and oil contents of the above 25 seed samples vary respectively from 3.5% to 6.5% and 44.5% to 55.9%.

### Discussion of the Results :

From Table I, it will be seen that for all the 177 samples (two samples i.e., S-65 B and S-160 excluding), the oil content varies from 42.3% to 56.5% (Barring sample S-2 which was not an authentic one, as it was purchased in local market and a higher boiling range solvent used in its extraction), moisture from 2.3% to 7.1%, the F.F.A. of the oil in the seeds from 0.07% to 6.0% (but mostly between 0.1% to 2.5%) and the shelling percentage from 18.1% to 33.9%. The F.F.A.'s of 11.0%, 10.4% and 9.2% respectively for the samples S-80, S-78 and S-82 are not taken into account, as these shelled samples were damaged and became wet in transit. The average oil content of the 177 samples on a 5% moisture basis works out to 50.3% which is higher than that of the seeds in several other groundnut producing countries. This average value for oil content (on 5% moisture basis) of all the combined varieties in the Andhra and Madras State area is also slightly higher than the values reported for oil content of the improved strains in the various States. It should also be mentioned, in passing, that the oil contents of 56.1%, 55.8% and 55.5% (on 5% moisture basis) in the samples S-5 (Madurai Dt.), S-103 (Krishna Dt.) and S-101 (Kurnool Dt.) are among the highest ever reported so far. (2,3) From the literature, it could be traced that only one other sample is reported to have an oil content of 55.6% calculated on the same 5% moisture basis (2) in 1917 from Texas. The oil contents of 55.3%, 55.2% and 55.0% respectively in the samples Nos. S-112, S-5 and S-12, all Coromandel variety, are also unusually high even for the improved varieties of Groundnuts.

The maximum, minimum and the average values for oil content (on 5% moisture basis) and shelling percent for all samples from the two States for each variety and the maximum and minimum limits of F.F.A. of the Oil in the seeds, separately for these varieties are worked out. The data is given in Table III.

## TABLE III

**Giving the limits of oil content, F.F.A. of oil and the Shelling percentage and averages for the important varieties of Groundnuts in Andhra and Madras States.**

| Serial No. | Variety | No. of samples analysed | Oil content—per cent (on 5% moisture basis.) | | | F.F.A. per cent. | | Shelling per cent | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min. | Max. | Mean. | Min. | Max. | Min. | Max. | Mean. |
| 1 | 2 | 3 | | 4 | | 5 | | | 6 | |
| 1. | Coromandel | 74 | 45.0 | 56.1 | 50.4 | 0.07 | 6.0 | 22.3<br>*(24) | 33.9 | 25.9 |
| 2. | Peanut | 59 | 44.0 | 55.5 | 50.7 | 0.11 | 3.9 | 23.0<br>*(22) | 33.5 | 27.5 |
| 3. | Departmental Strains (TMV-1 TMV-2, TMV-3) | 40 | 42.0 | 55.8 | 49.5 | 0.14 | 1.8 | 21.1<br>*(15) | 30.1 | 25.4 |

NOTE: The Mean value for F.F.A. is not given.

*Figures indicate the number of samples for which shelling percentages are determined.

From the data in Table III, it is seen that the lowest oil content is found in a T.M.V. sample and the highest oil content in a Coromandel sample. The average oil content of the peanut varieties is found the highest and that of the Departmental strains in bulk production is found to be the lowest, but the differences are so slight that no inferences can be drawn, based on this data. The F.F.A. of the oil in the T.M.V.s appears to be somewhat lower than in the other two varieties. The shelling percentage of the T.M.V.s is the lowest and that of the peanuts is the highest, which is a consideration in favour of cultivaing the departmental strains. However, it is considered that further data is necessary to confirm the above conclusions.

Table I contains the oil content and F.F.A. for both the shelled and unshelled samples of the same variety from the same locality. Out of fifty-eight such cases, the F.F.A. of the oil in thirty-one shelled seeds is found to be greater than that in the unshelled seeds, in twenty-five cases, it is less in shelled than in the unshelled seeds and in two cases it is the same in both. As for the oil content, out of sixty such cases in twenty-nine, it is found to be less in the shelled seeds than in the corresponding unshelled seeds in twenty-eight, it is found more in the unshelled seeds and in two, it is the same. From the above data, it is considered that no definite conclusions could be drawn. without obtaining more data.

From the data given in Table II, the protein content of the groundnut samples (kernels) varies from 21.0% to 32.1% with an average of 25.0% for the twenty-five samples. The average protein content of each of the three varieties are 24.6% for Coromandel seeds (of six samples), 24.6% for peanut seeds (of eight samples) and 25.5% for Departmental strains, TMV-1, TMV-2, TMV-3 (of elevan samples). Thus, the protein contents of TMV-1, TMV-2 and TMV-3 appears to be slightly hibher than that of the other two varieties on the average. It also appears that the protein content of the South Indian groundnuts is somewhat lower than that of the American and Philippine groundnuts but not lower than the Chinese or the West African peanuts (3).

**Summary and Conclusions:**

1. One hundred and eighty shelled and unshelled samples of different varieties, drawn from three harvesting seasons, representing bulk production of groundnuts, have been obtained from Andhra and Madras States and analysed. The data is presented.

2. Twenty-five samples of different varieties of groundnuts from different localities were analysed for protein content and the data presented.

3. The limits of oil and moisture contents, shelling percentage and F.F.A. of the oil in the seeds are found to vary, respectively, from 42.3% to 56.5%, 2.3% to 7.1%, 18.1% to 33.9% and 0.07% to 6.0%.

4. The average oil content of 50.3% for 177 samples of groundnut of the three important varieties produced in Andhra and Madras States is considered higher than the average oil content of groundnut produced in most other countries.

5. The highest oil contents ever reported, namely, 56.1%, 55.8% and 55.5% (on 5% moisture basis) are found respectively in samples S-6 Madurai Dt.), S-103 (Krishna Dt.) and S-101 (Kurnool Dt.). Closely followed by 55.3%, 55.2% and 55.0% of oil, respectively in Samples S-112. S-5 and S-12.

6. Average oil content of Peanut variety is found slightly higher than that of the Coromandel and the T.M.V.s. and the shelling percentage in the T.M.V.s is found to be lowest.

7. The oil content and the F.F.A. of shelled and unshelled samples of the same variety from the same locality in sixty cases gave conflicting results. (Further work in this direction is in progress).

8. The protein contents of South India groundnuts are found to be lower than those of the American and Philippine groundnuts but of the same order as those in the groundnuts produced in China and the East and West African areas.
   Further work is in progress.

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# GENERAL DEVELOPMENT OF COTTONSEED UTILIZATION IN INDIA

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**Cottonseed, in the United States of America, is now converted into hundreds of articles of great utility and economic importance, while India is far behind in this respect. Recently, however, the Government of India have been giving great impetus to the development of the cottonseed industry in this country.**

**Of the four main constituents of the cottonseed, namely, oil, cake, linters and hulls, oil has the highest monetary value amounting to about 55 per cent of the total seed value, that of linters being about 12 per cent. Based on the estimated yield of cottonseed of about 14 lakh tons during 1953-54, it would have been possible to obtain about 2.2 lakh tons of oil by mechanical extraction alone and about 1.4 lakh bales of linters of 400 lbs. each from the seeds of the American varieties alone. It will be seen that these two constituents of the cottonseed will yield a huge wealth to the country, when fully exploited.**

**It is, therefore, suggested that the cotton-growing tracts of the Indian Union may be divided into four convenient zones, and cottonseed crushing factories instlled at suitable stations.**

**A number of products of utility that could be prepared from the cottonseed have been enumerated in this note.**

**This note is, therefore, intended to bring home to the Government and the private sector the immediate necessity for converting the potential wealth of the cottonseed to its kinetic form.**

The value of cotton lint as a textile raw material is well-known, but the economic importance of all the constituents of the cotton plant has not been fully realised in this country. Cottonseed is being used only as cattle feed from very early times. The industrial utilisation of the cottonseed is just being planned in our country, whereas the U.S.A. has already developed it to the fullest extent during the past half-a-century. The Government of India is giving encouragement to the promotors of the cottonseed industry and have also fostered many Research Programmes in different institutions in this connection. It may be mentioned here that the Indian Central Cotton Committee have undertaken investigations on the linter output of different varieties of cottonseed, and also on their oil content with a view to growing cotton varieties which give higher oil content without sacrificing the lint qualities.

The main products of the cottonseed are: Oil, Cake or Meal, Linters and Hulls. All these products are of high industrial value and can bring good monetary return to the country immediately, even if the industries which make use of these products are started at a later date. These products are present in the seed in the following proportions :—

| | | | |
|---|---|---|---|
| Oil | ... ... ... | 15% to 23% |
| Cake of Meal | ... ... ... | 35% to 55% |
| Hulls | ... ... ... | 20% to 30% |
| Linters | ... ... ... | 2% to 10% |

The rest being moisture.

Further, it has been estimated that the money value of oil, cake or meal, linters and hulls, is respectively 55%, 29%, 12% and 4% of the total value of the seed products.

**Experiments Conducted by the Technological Laboratory :**

India produces mainly two varieties of cotton, viz., Deshi and American Upland. The seeds of these varieties are covered with fuzz, called linters, which has to be extracted by means of special de-linting machinery. Investigations carried out by the Technological Laboratory of the Indian Central Cotton Committee at Navsari and at Hubli in factories, where modern de-linting machines have been installed, showed that the Deshi types yield only 1 to 2% linters, where as the American varieties yield about 8%. The linter content of the different cottons obtained are given in the following tables:—

**Navsari Factory :**

| Variety of seeds | Linters |
|---|---|
| (a) **American:** | (%age) |
| M.A.5 | 7.2 |
| 216F | 8.3 |
| Parbhani-American | 8.7 |
| Cambodia Co.2 | 10.1 |
| Buri 107 | 6.2 |
| (b) **Deshi:** | |
| Suyog | 1.4 |
| Jarila | 1.1 |
| Indore-Malvi | 1.1 |
| Mollisoni | 1.1 |

**Hubli Factory:**

| Variety of seeds | Linters |
|---|---|
| **American:** | (%age) |
| Gadag Laxmi | 8.4 |
| M.A.5 | 7.8 |
| Co.2 | 8.0 |
| M.C.U.1 (Rajapalayam) | 7.6 |
| M.P. Cambodia | 6.5 |
| Mewar-American | 5.8 |
| Parbhani-American | 9.3 |

It will be seen from the above data that it may not be economical to use deshi types for de-linting purposes, but the oil-content of the seed of these varieties lies within the range of 15 to 23%, as has been stated already. It may, however, be mentioned that the American varieties, which possess lint of long staple, generally give a higher percentage of oil than the Deshi types.

### Estimate of the Production of Cotton Seed Products in India:

The total production of lint in India during 1953-54 was about 40 lakhs bales of 392 lbs. each; out of this, 22% was of the American variety, the rest being Desi type. Taking the seed output as about twice that of lint, the total quantity of cottonseed produced was about 14 lakh tons, the seeds of the American varieties constituting about 3.2 lakh tons. Taking the linter content of the seed as 8 per cent; on an average, the quantity of the linters that could be produced from the American types alone would be about 1.4 lakh bales of 400 lbs. each.

Now, as has already been stated, almost the whole of cottonseed produced in India is used as cattle feed. The large sized seeds of American type are not much favoured for this purpose, because it is thought that the fuzz on them is injurious to the digestive system of the cattle, although this notice is contrary to the experimental evidence. Furthermore, experiments have shown that the cake or meal contains a residual oil of about 7 per cent after mechanical extraction and this cake is found to be far superior to the whole seed as an animal feed, because it is richer in proteins, vitamins and minerals, and the lower fat-content is more than sufficient even for the milch animals. Therefore. the total quantity of the cottonseeds produced, barring a small portion required for replanting purposes, could be utilised for crushing and the cake reverted back to the market without causing any disturbance in the present economy. On the basis of figures for 1953-54, the total oil production by mechanical extraction can be estimated to be about 2.2 lakh tons. Further, it may be mentioned here that nutritional experts have found that only the milch animals require the fat content of 6 to 7%, whereas the work animals require much less, and consequently, the total oil production might be further increased by means of solvent extraction of a portion of the total cake yield.

### Establishment of the Cottonseed Industry on zonal basis.

It will thus be seen that there is a great scope for the development of the cottonseed industry in this country. There should, however, be good planning for its proper development in regard to the location of the factories, etc.

It is tentatively suggested that the country may be divided into four zones: viz., (1) East Punjab, covering East Punjab, Pepsu and Uttar Pradesh, (2) Madhya Pradesh, covering Madhya Pradesh, Madhya Bharat, Northern Bombay and Hyderabad; (3) Bombay, covering Southern Bombay, Mysore and

Andhra and (4) Madras. In each zone, composite units of de-linting and crushing machinery should be installed.

There are a few oil mills in the country, in the Punjab, Madhya Bharat, Bombay and Hyderabad, which process cottonseeds besides other oilseeds in the undecorticated state for the production of oil. But this has not proved a success for various reasons, the most important being that the oil content of the cottonseed is low compared with other oil-bearing seeds like groundnut. Furthermore, the oil-bearing kernel is encased in the hull, and if the whole seed is crushed not only does the weight of the hulls reduce the expeller capacity, but the hulls absorb some of the oil, thus reducing the oil yield. As far as we know, there are at present about six composite mills engaged in producing linters and oil with modern equipment, three of which are in Madhya Pradesh, two in Bombay State and one in Hyderabad. Hence, the establishment of composite factories on zonal basis is an urgent necessity if the industry is to be put on a sound footing. For the economical running of these factories it is essential to have a continuous supply of seeds without transhipment over long distances and to have proper storage facilities. Bad storage conditions rapidly deteriorate the seed quality due to the attack of micro-organizms. For this purpose, it is necessary to build modern storage godowns with proper ventilation, aeration and temperature-control.

A fully equipped cottonseed processing unit would consist of pre-cleaning equipment, delinting machinery, huller or decorticator, screens for separating the hulls from the kernel, crusher or roller for pressing kernel in order to ensure proper cooking, cookers to cook the meal at 140° to 220°F, and expellers for extraction of oil. The crude oil extracted is to be further refined in refineries and the meal obtained may be mixed in special mixers with the hulls to form cakes suitable for live-stock feed.

## Chief uses of Cottonseed-Products and Scope for the Development of Ancillary Industries :

Some uses of the four products of cottonseed, namely, oil, linters, cake and hull are given below:—

(1) **Oil** : The crude oil produced is refined by removing the fatty acids and by decolouring and deodorising, and used as an edible oil, for hydrogenation purposes, as butter substitute, etc., the foots obtained during the refining process can be used in the soap industry.

(2) **Linters**: Linters provide high-grade cellulose, useful for the manufacture of acetate and viscose rayons, explosive materials, lacquers, absorbent cotton, etc., etc.

(3) **Hulls**: Hulls recovered in cotton-seed milling possess nutritive value and may therefore, be mixed with meal for livestock feeding. Hulls

form an excellent source of fertilizer minerals and can be used as fillers in plastic industry and in the manufacture of active carbon, xylose and furfural.

Once the cottonseed delinting and crushing industry is firmly established in India, the above-mentioned uses of the four products open up a wide field for the establishment of many ancillary industries. The oil produced necessitates the establishment of fully-equipped refineries to obtain edible oil, and the refined oil helps the starting of more hydrogenation plants. Secondly, with the production of the low-grade oil, toilet and paint industries could be developed. The present production of linters by the existing factories in India is so small that it is not economical to further process it to serve as raw material for the rayon industries, and therefore, the rayon industries in the country have to depend on imports for their pulp requirements. It may be remarked here that if all the cottonseed of the American varieties grown in India is delinted, there would be sufficient material for establishing bleacheries, which would provide high-grade cellulose both for defence and rayon industries. Hulls would assist the starting of several small scale chemical industries.

The foregoing brief account of the possibilities of establishing cottonseed industry on a commercial scale in India is intended to show how much of wealth lies hidden in the cottonseed and the imperative need to exploit it to improve the economy of the cotton-growing industry in particular and that of the country in general.

# A REVIEW OF OILSEEDS PRODUCTION IN INDIA WITH SPECIAL REFERENCE TO THE INDIAN CENTRAL OILSEEDS COMMITTEE AND ITS WORK

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**India, the third largest producer of oilseeds in the world produced in 1954-55, 58.77 lakh tons of the five major oilseeds — groundnut, sesamum, mustard, linseed and castor, exceeding thereby the First Five Year Plan production target by 3.7 lakh tons. The targetted production increase for the Second Five-Year Plan is 70 lakh tons. The Indian Central Oilseeds Committee, set up in 1946 for the development and improvement of the oilseeds industry is now financing about 50 schemes for agricultural research and development including the evolution of improved varieties of seeds, multiplication and distribution of such seeds and the working out of economic methods of pest and disease control.**

**Stepping up the production of oilseeds has become necessary for the three fold purpose of meeting the increasing demand for edible oils as a source of fat in the dietary of the people, of feeding the soap, paint, varnish, vanaspati and other industries and of exporting to foreign countries to earn foreign exchange.**

**It is not feasible to increase the area under oilseeds, as priority has to be given to food crops. It is only by intensive cultivation that production can be raised. This is proposed to be achieved by distributing high yielding varieties of oilseeds and using more and more fertilizers in oilseeds cultivation. The tempo of production under the First Five-Year Plan leaves no doubt that the targetted increase under the Second Plan will be achieved.**

India is the third largest producer of oilseeds in the world, being only next to the U.S.A. and China in this respect. Oilseeds occupy an important place in this country's agricultural and industrial economy. About 29.3 million acres or 8.7 per cent of our total cultivated area is devoted to the major oilseeds crops such as groundnut, sesame, mustard, linseed and castor, producing annually about 58 lakh tons of these oilseeds. Besides these major oilseeds, a number of minor oilseeds are also grown in India, although in small quantities.

The oils obtained from our oilseeds not only enter into the dietary of the people as a principal source of fat, but form important raw materials in the manufacture of soaps, paints, vanaspati, varnishes, lubricants, etc.

From the nutritional point of view the minimum per capita consumption of fat should be at least 45 lb. per annum. As against this the availability of vegetable oils for edible purposes in India is limited to 7 lb. per head. The manufacturing industries mentioned above also demand increasing quantities of vegetable oils. It is also necessary to develop the export trade in vegetable oils in order to earn valuable foreign exchange.

The need for stepping up the present production of oilseeds thus becomes obvious.

Increase in production cannot be achieved by increasing the existing area under the major oilseeds crops, as priority has to be given for the production of food crops. We have, therefore, to depend largely on intensive cultivation of the already available area. India's per acre production of Oilseeds is exceedingly low compared to that of some other countries. Take, for example, groundnut. The Indian per acre yield of this important oilseed in 1953-54 was 744 lb. only whereas in China and U.S.A. in the same year it was 1,456 lb. and 1,023 lb. respectively. There is thus a great deal of scope for increasing the production from the existing area by the adoption of intensive cultivation methods such as the use of improved varieties of seeds, application of fertilisers, etc.

The stepping up of the production of oilseeds in India comes within the purview of the functions of the Indian Central Oilseeds Committee which has been set up under the Indian Oilseeds Committee Act of 1946 for the improvement and development of the cultivation and marketing of oilseeds (other than coconut and copra) and of the production, manufacture and marketing of oilseeds products.

The Committee is charged with the development of India's five major oilseeds, namely, groundnut, sesame, rape, mustard, linseed and castor and a number of minor oilseeds such as mowha, kardiseed, niger, etc. The Committee has on it 65 members representing the Central and State Governments and such interests as growers, the co-operative movement, oil technology, village oil crushing industry, the export trade, the Federation of Indian Chambers of Commerce and Industry, trade association, consumers, etc.

The Committee derives an income of about Rs. 15 lakhs per annum from the levy of a duty of excise at the rate of 1 anna per maund on all oils extracted from oilseeds crushed in any power driven mill in India and a duty of customs at the rate of 2 annas per maund on all oilseeds exported out of India.

The Committee finances from its funds 143 schemes, contributing the entire expenditure in some cases and sharing it with State Governments in others. The schemes relate to agricultural and technological research development of co-operative marketing and the village oil industry and survey of minor oilseeds.

A detailed study by an expert, shortly after the Committee was set up revealed that, except in the States of Madras, U. P., Hyderabad and Bombay nothing much had been done to develop oilseeds crops. On the basis of the expert's recommendations, the Committee has initiated research on oilseeds crops in a number of States.

These schemes have broadly speaking the following objectives

(1) Evolution of improved varieties of seeds combining high oil content with resistance to pests, diseases and drought

(2) Working out schedules of cultural and manurial practices, seed rate, spacing etc.

(3) Working out economic methods of controlling pests and diseases on a regional basis.

(4) Multiplication and distribution of improved varieties suited to each tract.

The Committee has impressed upon the State Government the need to take expeditious action for trying out systematically the varieties of improved seeds already evolved so that they may be introduced on a wide scale. About 50 schemes for agricultural research and development are now financed by the Committee all over the country.

The Committee is financing about 25 schemes in oil technology in different institutions and has recently decided to take over the Oil Technological Research Institute at Ananthpur and develop it into a Central Institute of Oil Technology.

The Committee has so far sanctioned 166 schemes for developing the village oil crushing industry. 24 of them have been completed and the remaining ones are in different stages of progress. They are being worked by State Departments, research institutes and universities.

The post war years have witnessed a decline of about 10.99 lakh tons in the export of oilseeds from India. This is no doubt partly due to the Government of India's policy of encouraging the export of oils in preference to oilseeds. But the other and weightier reason is the increased consumption of vegetable oils not only for edible purposes but for the manufacture of soaps, paints, varnishes, lubricants and vanaspati.

Under the First Five-Year Plan it was decided to fix 4 lakh tons as the target for extra production to be achieved by 1955-56. The increase in production were to be brought about by intensive cultivation without encroaching upon areas under food crops. Accordingly schemes for the multiplication and distribution of improved varieties of oilseeds which would ensure higher yield with better oil content, have been started in different parts of the country by the State Governments with financial aid from the Committee. Seed multiplication schemes have been in progress in the States of Madras, Andhra, Hyderabad, Saurashtra, Punjab, West Bengal and Assam. They have been sanctioned for Bombay, Bhopal and Mysore also.

The production of oilseeds in the base year of 1950-51 was of the order of 51.03 lakh tons. Although in the first two years of the plan period, owing to adverse seasonal conditions, production was below that in the base year, in 1953-54 it rose to 56 lakh tons exceeding the target of 55.03 lakh tons. The production in 1954-55 rose still further to 58.77 lakh tons, that is 3.7 lakh tons more than the target figure.

The target for oilseeds under the Second Plan is 70 lakhs of tons by the end of 1960-61. The production of groundnuts is to be stepped up to 47 lakh tons, that of rape, mustard, sesame and linseed to 21.39 lakh tons and castor to 1.61 lakh tons. We may well hope to attain the target having regard to the present tempo of production.

A development programme costing Rs. 1.15 crores has been envisaged for oilseeds under the Second Plan. It includes schemes (1) for the multiplication and distribution of high yielding varieties of oilseeds already evolved so that the entire area under oilseeds is covered by improved varieties; (2) for the organisation of demonstration plots in selected localities to demonstrate the advantages of growing improved strains and adopting improved agricultural practices; (3) for the distribution of manures and fertilisers; (4) for controlling pests and diseases, and (5) for conducting crop competitions for oilseeds.

Reliance will, however, be laid mostly on items (1), (3) and (4) above for achieving the targetted increase. The State Governments have also been requested to increase the area under oilseeds without encroaching upon the area under food crops. The Oilseeds acreage could be expanded by bringing fallow lands under the crops and such lands as remain uncultivated after the main crop.

The year 1953-54 witnessed bumper harvests for all oilseeds crops in India. From an area of 12.649 acres, we produced 38.23 lakh tons of groundnuts. In the same year the Commonwealth production of groundnuts was estimated at 53 lakh tons accounting for 48 per cent of the world total. It may be seen from these figures what an important place India occupies in the field of groundnut production. With the completion of the river valley projects, it is hoped that the crop will be less subject to the vagaries of the season and that with an increasing domestic demand and prices remaining sufficiently attractive it will be possible for growers to maintain the rising tempo of production.

The 1953-54 Indian production of sesamum constituted nearly 50 per cent of the world production (excluding China's); from 6,132,000 acres, 5,13,000 tons of sesamum were produced. The area and yield figures for 1954-55 were 6,460,000 and 5,92,000.

India's mustard production in 1953-54 was 8,26,000 tons from an area of 5,373,000 acres. In 1954-55 it was 9,62,000 tons from 5,665,000 acres.

Linseed production in India in 1953-54 was of the order of 3,55,000 tons from an area of 3,369,000 acres. In the next year it rose to 3,88,000 tons from an area of 3,290,000 acres.

The production of castor which in 1953-54 was 1,07,000 tons from an area of 1,530,000 acres, rose to 1,12,000 tons in the next year although the area had gone down to 1,273,000 acres.

It will thus be seen that the area under and production of oilseeds in India which in 1950-51 were 26.5 million acres and 51.03 lakh tons respectively rose to 29.3 million acres and 58.77 lakh tons in 1954-55.

If the present tempo in augmenting production is kept up and the schemes already initiated and those contemplated under the Second Plan are earnestly worked out, there is little reason to doubt that the increase of 70 lakh tons targetted for oilseeds under the Second Plan will certainly be achieved, if not surpassed.

# IMPROVEMENT OF OILSEED CROPS IN BOMBAY STATE

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Oilseed crops occupy about 9 per cent of the total area sown to different crops in Bombay State. Botanical improvement of these crops is briefly described in this paper.

Groundnut: Improvement of groundnut crop was taken up at the Government Farm, Dharwar and the strains Pondichery-8, Spanish Peanut No. 5 and Spanish Improved were evolved. In the Deccan, two strains, Kopergaon-1 and Kopergaon-3 were evolved. Recently, improvement of this crop has been undertaken in an important regions. A number of promising selections are undergoing trials at various farms.

Safflower: Selection work was taken up in Safflower at Niphad and improved strain No. 630 was evolved giving 10 per cent higher yield than local. A new selection No. 62-8 is giving good results in Nasik, Bijapur and Sholapur districts.

Sesamum: Selection work in Sesamum was taken up at Niphad and strain No. T. 85, was isolated, having bold white grain and giving higher yield and oil content than local. Recently improvement work has also been taken up at Dhulia (W. Khandesh) and Bhuwa (Broach).

Castor : Castor is mainly grown in Gujarat, where two strains, S-5 and S-20 were evolved. The strain S-20 is found suitable for cultivation in Ahmedabad, Kaira, Panchamahals and Dharwar Districts.

Linseed: Linseed is mainly grown in the Deccan and Karnatak. Two High yielding strains Malsiras-10 and Sholapur-36 were evolved. The former was found suitable to Nasik district and the latter to Sholapur and Nagar districts. At Niphad these have been crossed with outside types with a view to combine economic characters.

Niger : Selection work was undertaken in Niger at Poona and two strains viz. A and B were evolved. Niger-B gives good results in Bijapur. Dharwar and Nasik districts.

The oilseed crops occupy about 9 per cent of the total area of different crops sown in Bombay State. The area under principal oilseed crops in Bombay State is given in the following table.

| Oilseed crops. | Area in acres (1951-52.) |
|---|---|
| (1) Groundnut | 30,12,600 |
| (2) Safflower | 3,85,100 |
| (3) Sesamum | 3,82,600 |
| (4) Castor | 1,43,000 |
| (5) Linseed | 53,900 |
| (6) Niger | 47,900 |

The improvement work in oilseeds at present, forms part of the Scheme for improvement of Cereal, Pulse and Oilseed crops of the Bombay State. Before 1947 the work on Safflower, Sesamum, Linseed and Niger was carried out under the Economic Botanist with financial aid from the Sasoon David Trust fund.

**Groundnut:**

Groundnut is the most important oilseed crop of the Bombay State and is extensively cultivated in the Deccan and Karnatak divisions. It is grown on a large scale in the districts of East Khandesh, West Khandesh, Satara, and Nasik, in the Deccan, Belgaum, Bijapur, Dharwar and Sholapur, in the Karnatak and Sabarkantha, Panchmahals and Amreli in Gujarat.

Improvement of groundnut crop was taken up by the Cotton Breeder at the Government Farm, Dharwar and three strains were evolved viz. Pondichery-8, Spanish Peanut No. 5 and Spanish Improved. Pondichery-8 is a late maturing spreading type giving 30 per cent higher yield and 4 per cent more oil content than the local type. Spanish Peanut No. 5 is an early erect type giving 10 per cent higher yield and 7 per cent more oil content than the local type. Spanish Improved is an early erect type, giving 12 per cent higher yield and 7 per cent higher oil content than the local type, and suffers less from drought and 'Tikka' disease.

In the Deccan, selection work was undertaken at Kopergaon farm and two strains, Kopergaon-1 and Kopergaon-3 were evolved. The strain Kopergaon-1 is a semi-erect type giving 37 per cent higher yield than local and more suitable to heavier soils. Kopergaon-3 is an erect type giving 28 per cent higher yield than local. It has three-seeded pods and is more suitable to lighter soils.

Recently improvement of this crop has been undertaken at the Agricultural Research Stations at Jalgaon (E. Khandesh), Dhulia (W. Khandesh), Karad (N. Satara), Mohol (Sholapur), Bijapur, Bailhongal (Belgaum) and Dohad (Panchmahals). There are a number of promising selections on hand in both the early and spreading varieties which are undergoing trials at these farms.

Spanish Improved is still holding the ground among the early erect types and its adaptability is being tested by trials in the various districts.

Hybridization work to combine resistance to 'Tikka' disease and for inducing dormancy has been taken up at Jalgaon and Mohol. Types possessing dormancy of seed do not easily germinate in the field even if the crop is caught in rains before harvest. At Annigeri one selection T-6-2 has been found to give higher oil percentage of 49.9 as against 44.3 of Pondichery-8. At Amreli the introduced type AH-32 (T.M. V-2 of Madras) is found to give good results in trials on the farm as well as on cultivator's fields.

Groundnut being a leguminous crop, is not generally manured. Rotational experiments with Cotton and Jowar are in progress at Jalgaon and Dharwar and the indications are that groundnut forms a good rotation with these crops. Spacing-cum-seedrate experiments conducted from 1951-54 show that the spacing seedrate interaction is nonsignificant at Bailhongal, Dohad and Jalgaon. On an average 12" spacing between rows and 100 lb. seedrate for the early type (Spanish improved) have given better results. At Bijapur 15" spacing and 100 lbs. seedrate, and at Annigeri 12" spacing and 120 lbs. seedrate have given the best results for the Spanish Improved type. For the spreading variety Pondichery-8, 12" spacing and 80 lbs. seedrate is found to be the best at Bijapur.

**Safflower:**

Safflower is cultivated in the **rabi** season mostly as a mixture crop in wheat and **rabi** jowar in the Deccan and Karnatak, mostly in the districts of Ahmednagar, Poona, Sholapur and Bijapur. Selection work was taken up at Niphad and improved strain No. 630 was evolved giving 10 per cent higher yield than the local types. It was found suitable for cultivation in Nasik and Ahmednagar districts. Selection work was also carried out by the Economic Botanist at Poona and promising selections, A and B evolved but they were not found suitable in districts. At Niphad a new selection No. 62-8 has been evolved which is giving good results in Nasik, Bijapur, and Sholapur districts. Selection work has been taken up at Karad (N. Satara) and Mohol (Sholapur) in the Deccan and at Annigeri (Dharwar), Bailhongal (Belgaum) and Bijapur in the Karnatak. At all the above stations promising selections are under large scale trials. At Annigeri the selection, Bevoor-26 has bolder seed and 2 per cent higher oil content than the local type. The new selections S-30 and S-482-1 are being tried in Dharwar and Bijapur districts.

**Sesamum:**

Sesamum is another important oilseed crop of Bombay State grown in the Kharif season mainly as a mixture crop with Cotton or Bajri and occasionally as a sole crop. The districts in which it is mainly grown are Sabarkantha, Banaskantha, Ahmedabad and Panchmahals in Gujarat, West Khandesh, East Khandesh, Ahmednagar and Nasik in the Deccan and Dharwar and Bijapur in the Karnatak.

Selection work was taken up at Niphad. As a result of this work Strain No. T-85, was isolated having bold white grain and giving higher yield and oil content than local. It is now spreading in Nasik, Ahmednagar and East Khandesh districts. Recently improvement work has also been taken up at Dhulia (W. Khandesh) and Bhuwa (Broach). At Niphad some of the new selections are giving better yield than T-85. Hybridization work has also been taken up between T-85 and outside types to combine high yield and non shattering habit and resistance to phyllody. Three selections from Dhulia are being tried in W. Khandesh District.

**Castor:**

Castor is an important oilseed crop particularly from the point of view of export trade. It is mainly grown in Gujarat, in the districts of Mehsana, Banaskantha, Sabarkantha and Ahmedabad. It is also important in W. Khandesh (Deccan) and Dharwar (Karnatak) districts. The crops are raised both in the **kharif** and **rabi** seasons either pure or as a mixture with other crops.

The work on castor improvement was initiated by the Deputy Director of Agriculture, Surat at the Tobacco Breeding Station, Nadiad and two improved strains S-5 and S-20 were evolved. The strain S-20 possessing small, uniform seed, higher oil content and giving 15-20 per cent higher yield than local is found suitable for cultivation in Ahmedabad, Kaira and Panchmahals districts and is spreading in that tract. In Dharwar district also it is found to give about 33 per cent higher yield than local.

**Linseed:**

Linseed is grown in the **rabi** season either as a sole crop or as mixture with wheat, **rabi** jowar or gram. It is mainly grown in the Deccan and Karnatak. The main centres of cultivation are Nasik, Sholapur, Bijapur and Dharwar districts. Work of linseed improvement had been carried on in the earlier years by the Economic Botanist. Two high yielding strains Malsiras-10 and Sholapur-36 were evolved. The strain Malsiras-10 was found suitable to Nasik district and was therefore spread in that district through a seed multiplication scheme, financed by the ICAR. The strain Sholapur-36 was found suitable to Sholapur and Nagar districts and is being spread in that region. Recently selection work has also been undertaken at Mohol (Sholapur) and Bijapur. At Niphad the two standard strains have been crossed with outside types with a view to combine high yield, high oil content and resistance to wilt and rust and the synthetic material is being studied.

**Niger:**

Niger is mainly cultivated in the Deccan during the **Kharif** season, mostly as a mixture crop and seldom as a pure crop. The important districts growing this crop are Poona, Ahmednagar, West Khandesh, Bijapur, Dharwar and Ratnagiri. Selection work was undertaken by the Economic Botanist at

Poona and two strains viz. A and B were evolved. Niger-B gives 10 per cent higher yield than local, has 37 to 39 per cent oil content and is found to give good results in Bijapur, Dharwar and Nasik districts. Selection work has been recently taken up at Niphad (Nasik) and Kopergaon (Ahmednagar) and selections giving higher yield than Niger-B are undergoing trials on the farms.

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# STUDIES ON THE STORAGE OF VEGETABLE OILS IN COLOURLESS AND DEEP-GREEN BOTTLES.

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A number of vegetable oils, viz. groundnut oil (crude), groundnut oil (refined), sesame oil (crude), mustard oil (crude), coconut oil (crude), castor oil (refined), olive oil (crude) and "vanaspati", were stored in colourless and deep-green glass bottles with a head space of 1½ inches for two years at a temperature range of 70-91°F (Mysore room temperature). As a result of estimations of peroxide values and acidity, it has been concluded that deep-green bottles are better than colourless glass bottles for the storage and marketing of above-mentioned vegetable oils.

Edible vegetable oils are generally stored in open metallic or earthernware containers in retail shops in India thus leading to a great deal of deterioration in their quality. This deterioration of edible oils can be checked to a considerable degree if the oil producers were to package their oils in small containers which may reach the consumers without being opened at any stage of transaction.

It has been established that glass containers are better than metalic ones for the storage of oils (1, 2). Coe and Leclerec (3, 4) have shown that oils stored in dark or green glass containers may remain free from rancid odour even though they may have peroxide values equal to or higher than those of oils exposed to visible light. Other workers (5, 8) have also shown that the green light of the visible spectrum is the least effective in accelerating the oxidative processes in oils.

It appeared to us that 26 oz. glass bottles would be the ideal containers for the storage and marketing of edible oils. It was, therefore, considered desirable to study the storage behaviour of a number of common edible oils when stored in colourless and deep-green 26 oz. glass bottles for a period of two years. The results of such a study are provided in the present paper.

Eight vegetable oils, viz., groundnut oil (crude), groundnut oil (refined), sesame oil (crude), mustard oil (crude), coconut oil (crude), castor oil (refined), olive oil (crude) and "vanaspati" were stored in colourless and deep-green glass bottles with a headspace of 1½ inches for two years at a temperature range of 70-91°F (Mysore room temperature), the bottles being kept corked throughout the period of experimentation. Estimations with regard to peroxide values and acidity were made at the beginning of the experiment and at the end of two years. Peroxide value was determined by tne Wheeler's method (9) and acidity by the method described by Jamieson. (10).

The data obtained are presented in Table I. The peroxide values were invariably higher in the case of oils stored in colourless bottles as compared to those stored in deep-green bottles for a period of two years. The decreases in peroxide values in the case of three oils can be explained as being due to the breaking down of peroxides during storage. On the other hand, the values for acidity were found to be practically the same in both the colourless as well as the deep-green bottles with respect to all the oils at the end of two years of storage.

As a result of storage investigations on 8 common edible vegetable oils, it has been found that deep-green glass bottles are better than colourless glass bottles for the storage and transportation of edible oils.

**Acknowledgement:**

Our thanks are due to Dr. V. Subrahmanyan, Director, for his keen interest in this investigation.

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## TABLE I

Peroxide values and acidity in 8 edible oils at the commencement and end of two years storage.

| Oil | Colour of Bottle | Peroxide Value * | | | Acidity * * | | |
|---|---|---|---|---|---|---|---|
| | | Initial | After two years | % increase | Initial | After two years | % increase |
| Groundnut Oil (Crude) | C | 8.0 | 38.32 | 379.0 | 2.05 | 2.44 | 19.0 |
| | G | 8.0 | 31.50 | 293.0 | 2.05 | 2.45 | 19.5 |
| Groundnut Oil (Refined) | C | 18.0 | 36.8 | 104.4 | 0.15 | 0.19 | 26.6 |
| | G | 18.0 | 34.7 | 92.8 | 0.15 | 0.18 | 20.0 |
| Sesame Oil (Crude) | C | 15.0 | 13.4 | —10.7 | 2.10 | 2.46 | 17.0 |
| | G | 15.0 | 12.5 | —17.0 | 2.10 | 2.40 | 14.3 |
| Mustard Oil (Crude) | C | 4.7 | 3.2 | —32.0 | 0.55 | 0.82 | 49.0 |
| | G | 4.7 | 3.0 | —36.0 | 0.55 | 0.82 | 49.0 |
| Coconut Oil (Crude) | C | 0.6 | 1.0 | 50.0 | 1.06 | 1.82 | 72.7 |
| | G | 0.6 | 0.9 | 66.6 | 1.06 | 1.76 | 66.7 |
| Castor Oil (Refined) | C | 0.9 | 1.3 | 44.4 | 0.86 | 0.94 | 9.3 |
| | G | 0.9 | 1.2 | 33.3 | 0.86 | 0.94 | 9.3 |
| Olive Oil (Crude) | C | 58.0 | 29.5 | —49.0 | 0.17 | 0.23 | 35.3 |
| | G | 58.0 | 20.9 | —64.0 | 0.17 | 0.21 | 23.5 |
| "Vanaspati" | C | 4.6 | 7.3 | 58.7 | 0.11 | 0.13 | 18.1 |
| | G | 4.6 | 6.7 | 45.6 | 0.11 | 0.13 | 18.1 |

*Milliequivalents of peroxide oxygen per kilogram of oil.

**Percentage oleic acid.

C—Colourless.

G—Green.

# SALSEED. A FOREST OIL-BEARING SEED AND ITS OIL

**Om Prakash, A. C. Gupta & S. Rai.**

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**Sal tree, botanically called Shorea Robusta, grows in abundance in the Tarai Forests of Northern India and also in Central India. The tree produces fruits containing kernels which yield a fat of pale green colour. The component fatty acids of the fat are Palmitic Acid 8.3%, Stearic Acid 34.7%, Arachidic Acid 12.3%, Oleic Acid 41.9% and Linolic Acid 2.8% which resemble to some extent that of Cocoa-butter, used in confectionery. The solvent extracted meal contains as major constituents starch 31.3%, Tannins 13.6% and Protein 12.1%. The tanning material in the cake is of Pyrogallol type and the general performance of the concentrated extract of the cake as tanning material is satisfactory. It is, therefore possible to exploit the large resources of Salseed for augmenting the fat supply in this country and utilise the fat after proper refining as a substitute for Cocoa-butter and also that of Tallow in soap making and as a Textile auxiliary. The cake may be utilised as a source of tanning material and the residual cake, after extraction of tanning may be utilised as manure due to increased percentage of nitrogen.**

Sal tree, botanically called **Shorea-Robusta**, grows in abundance in this country forming two distinct belts separated by the Gangetic Plain. The northern belt or the sub-Himalayan belt extends from Punjab to Assam and the Southern or the Central belt extends from the Coromandal coast west to Pachmari hills and south to Godawari river. The tree produces fruits containing kernel which yields 14 to 15% of a pale green fat on extraction with solvents. The correct data regarding the availability of salseed, in this country, is not available. Dr. Puntambekar[1], however, estimates the availability of the seed (on conservative side) to be about 1 million mds. The fat content of the seed, being rather low it has not been found economical so far to get the fat by mechanical means and hence the large resources of the seed has till now remained unexploited. However, with the development of solvent extraction in this country it should be possible to exploit the seed in the near future. In view, therefore, of possibilities of utilising the resources of the seed and thereby augmenting fat supply in the country it was considered desirable to study the problem with a view to its economic exploitation.

## Work Done :

A quantity of Salseed was obtained through the courtesy of the Central Silviculturist. The seed as received was in the form of dried fruits which on analysis gave 28% Petals, etc. and 72% seed. The seed was found to consist of 23.4% shell and 76.6% kernel and the latter contained 14.0% of a pale green fat on extraction with Petroleum Ether.

The fat on analysis gave the following results.—

| | |
|---|---|
| Sp. Gr. at 99°C/30°C | 0.8692 |
| Refractive Index at 40°C | 1.4579 (B.R. 47.8) |
| Acid Value | 10.6 |
| Saponification value | 190.0 |
| Iodine Value | 37.9 |
| R. M. Value | 1.0 |
| Melting Point | 34.7°C |
| Unsaponifiable matter | 0.96% |
| Hehner Value | 94.2 |
| Titre (of mixed fatty acids) | 53.4°C |

The fatty acids composition of the fats forms the subject of a paper which has been sent for being read at the next Indian Science Congress Association to be held at Agra. The results obtained are as under:—

| | |
|---|---|
| Palmitic Acid ... ... | 8.1 |
| Stearic Acid ... ... | 34.9 |
| Arachidic Acid ... ... | 12.3 |
| Oleic Acid ... ... | 41.9 |
| Linoleic Acid ... ... | 2.8 |

From the above it appears that constitution of sal fat resembles to some extent that of Cocoa butter which contains Palmitic Acid 24.4%, Stearic Acid 34.5%, Oleic Acid 39.1% and Linoleic Acid 2.0% as component fatty acids. As such there are possibilities of utilising the fat as a cheap substitute for Cocoa butter used in confectionery. It may also form a substitute for Tallow in soap making and as a Textile auxiliary.

**Utilisation Of The Cake:**

The cake obtained after extraction of the fat from the seed with solvent was analysed to find out its economic utilisation. The results obtained are as under:—

| | |
|---|---|
| Moisture and volatile matter ... ... | 12.6% |
| Ash ... ... | 3.6% |
| Fat ... ... | 2.2% |
| Crude Fibre ... ... | 4.3% |
| Protein ... ... | 12.1% |
| Sugars ... ... | 5.2% |
| True starches ... ... | 31.3% |
| Other polysacharides ... ... | 3.5% |
| Tannins ... ... | 13.6% |
| Aglucon of glycosides other than tannins | 3.8% |
| Phosphatides ... ... | 1.2% |

The above result suggested the utilisation of the cake as a source of tanning material and as a manure after extraction of the tannins. Experiments have been conducted in collaboration with a Tannery in order to assess the value of the cake as a source of tanning material. Penetration of the liquor in tanning the pelt was medium and the leather tanned with the concentrated extract of the cake gave a light brown colour. The general performance of the liquor as a tanning material was considered to be satisfactory. The tanning material in the cake is of pyrogallol type and hence the cake can be used in place of myrobalans, which have similar type of tanning material provided it is cheaper than the latter in terms of tannin, content. The residual cake after extraction of tanning material can be utilised as manure with better advantage due to increased percentage of nitrogen.

The results obtained from the work so far conducted on laboratory scale suggest the possibilities of economic utilisation of salseed and work on semi-large scale on the following lines is in progress under a grant from the Indian Central Oilseeds Committee.

(1) Finding out a suitable method for extraction of fat.

**Utilization of the fat.**

(2) Use of the fat as a tallow substitute in soap-making and as a Textile auxiliary.

(3) Refining of the fat for edible purposes with particular reference to its use as a substitute for Cocoa-butter in confectionery.

**Utilization of the Cake.**

(4) **As tanning material:—**

- (a) Finding out the best method of extraction of tanning material-designing of a suitable extractor.
- (b) Concentration of tanning material—designing of a suitable vacuum pan.
- (c) Practical trials of tanning material.

(5) Use of the residual cake after extraction of tanning material as a manure: The problem involves study of the following:--

- (a) Method of drying the residual cake.
- (b) Practical trials with the residual cake for its manurial value alone and in admixture with other manures.

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# DEVELOPMENT OF NEEM OIL INDUSTRY IN INDIA

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**In order to augment the oil and fat supplies of the country, neem and similar other oilseeds, vast resources of which exist in the country, must be fully exploited. Commercial use of neem oil is at present restricted on account of its very dark colour and unpleasant odour which is to some extent due to the bad quality of seed obtained by crude and unscientific methods. Extensive availability of neem fruit, reputed medicinal properties of neem oil and possibility of its utilisation in soap and other industries attracted the attention of many research workers, but most of this work has been directed towards determining of its characteristics and fatty acid composition and methods of its refining.**

**Work was, therefore, taken up for working out methods of scientific processing of neem fruit for its seed which may yield oil of low acid value, light colour and less odour. Processing of new fruit has been devised consisting of three operations—(i) depulping, (ii) drying and (iii) decorticating and machinery for these operations is being designed under a grant from the Indian Central Oilseeds Committee.**

India is the third largest oilseed producing country of the world, producing about 6 million tons of major oilseeds, yet its per capita per day consumption of fat is only 0.34 ozs. as against 2 ozs. recommended as the minimum requirement for edible purposes alone by the Nutrition Advisory Committee. In order to raise the consumption of fats it is essential to augment the resources of oils and fats in the country. Also at present some of the edible oils like groundnut and coconut are being used for industrial purposes. It is, therefore, imperative that edible oils should not be diverted to industrial uses. There are large untapped resources of oils in the country like Neem, Karanja, Rayana (Amoora Rohitika), Rohni, Banjh (Quercus Incana), Sal (Shorea Robusta), Bhaikal (Principle Utilis), Walnut (Junglans Regia), Apricot (Prunus Persica) and many others. If these resources can be exploited, a large quantity of extra oils can be made available, some of which can be used as edible oils like Bhaikal, Walnut and Apricot and other for soap making and other industrial uses which would thus help in preventing diversion of edible oils.

Neem oil can satisfactorily replace groundnut oil in soap making. The **potential resources of neem** oil are abundant in the country and it is by far the most important of the so far unexploited oils.

The neem tree (Azadirachta Indica) is found in large numbers all over the country. It grows wild even in oosar land and is a common avenue tree. It is found in house compounds, canal banks, road-sides etc. These trees yield several lac tons of neem fruit every year most of which goes to waste. The extent of wastage can be realised from the fact that in U.P. alone there are estimated to be 20 lacs neem trees capable of yielding about 45 lac maunds of neem seed equivalent to about 18 lac maunds of oil every year. Every effort should be made to put a stop to this collossal waste and harness this source for the prosperity of the country.

The neem fruit falls with the setting in of rains. Fresh fruit consists of a seed enclosed inside a pulpy matter which is covered with a thin skin. The seed itself consists of a shell and a kernel. The dry kernel which contains 45—50% of fatty oils constitutes 10% of the fresh fruit and 25% of the fruit dried as such. The fruit is more or less oval in shape, being ⅜" to ½" long and about ¼" thick. The kernal is about ¼" long and ⅛" thick.

The oily nature of the kernel and recovery of oil from it have been long known in the villages. Since ancient times the oil has been used locally as a remedy for skin diseases such as scrofula, indolent ulcers and sores and ring-worm and for rheumatism. It is also reported to possess anthelmintic and insecticidal properties. Besides, it has been used by villagers for burning as an illuminant and for lubrication of bullock-cart etc.

The above uses, however, cannot provide sufficient out-let for the oil if most of the available fruit is to be collected and utilised. This probably accounts for the non-development of this industry. It is also partly due to the scattered occurrences of neem trees and consequent difficulties in collection of the fruit coupled with the tedious method of processing the fruit into seed. The main obstacle in the use of the oil in Industry is its very dark colour and unpleasant odour, as obtained from the seed as at present prepared in villages by crude methods. In the areas with scanty rainfall like Rajasthan, the neem fruit itself can be easily and quickly dried and is marketed and stored as such. The dried fruit as such is pressed for oil on a certain scale. For crushing in village Ghanis the fruit has to be decorticated by crude methods to obtain the kernel which is then pressed for the oil. In areas where rainfall is sufficient, the fruit can neither be dried nor stored as such due to risk of deterioration. The processing has, therefore, to be carried out at the point of collection to obtain the kernel. The method at present consists in allowing moistened fruit to rot for some days washing it free from pulpy matter, drying the depulped seed in the sun as far as possible and finally decorticating it by breaking the shell with a flat wooden plank or disc and separating the kernel from the broken shell by winnowing. The kernel thus prepared is sold in the market. It still contains an appreciable amount of moisture due to which it gets "heated" during storage, getting darkened and losing its texture also to some extent due to which the yield of oil goes down and difficulty is experienced in crushing. The acid value of the oil obtained from this kind of seed is high, colour very dark and odour very unpleasant.

Extensive availability of neem and its high oil content have attracted the attention of research workers. Work however, has been mostly concerned with the characteristics of the oil, its constituents and its fatty acid composition (1,—6).

According to Rao & Seshadri (7) the oil has following constants—d/31°; 0.9129; ND/31°, 1.4658; Sap. value 195.6; Iod. value 69.2; Acid value 11.2. The fatty acids are chiefly oleic (about 53%), stearic (about 18%), and palmitic (about 14%) together with small amounts of linoleic and arachidic acids. The "margosic acid" of earlier workers was shown by Roy & Dutt (8) and Child & Ramanathan (9) to be a mixture of the usual fatty acids. The glycerides of neem oil have been investigated by Hilditch and Murti (10) and found to follow the usual rules of glyceride structure in oilseeds and fats. Investigations on the odorous constituents of the oil which are considered to be sulphur compounds have so far been inconclusive.

The bitter principles of neem oil have been investigated by several workers. (12, 15) Siddique & Mitra (16) have obtained the bitter principles by extraction with alcohol (yield 2%). Nimbidin (M. P. 90-100°; 1.2—16%) the principal component, is highly bitter and contains sulphur. Besides nimbidin two bitter compounds, free from sulphur (m.p. 192° and 205°) have been obtained in very small quantities. Nimbidin and sodium nimbidinate are almost non-toxic. Nimbidin preparations are reported to be free from the unpleasant smell of the oil and to be efficaceous in a variety of the skin diseases, sceptic sores and ulcers due to burns and in bleeding gums and pyorrhoea. Siddique has also obtained patents on the refining of neem oil, (17) bitter principles of Neem oil (18) and new derivatives of neem oil (19).

Thus though sufficient work has been done on the chemical characteristics etc. of neem oil, little attention seems to have been diverted to towards the scientific processing of neem fruit so as to obtain a good quality seed with good keeping qualities which is an essential prerequisite for obtaining a good quality oil with low acid value, light colour and minimum odour. Work in this regard was, therefore taken up (20) as a result of which the following conclusions were drawn:—

(1) Neem seed (kernel) at present available in commerce particularly in U.P. is prepared by crude, unscientific methods due to which the seed during storage gets "heated" on account of auto-oxidation and yields an oil with high acid value, very dark colour, and pronounced unpleasant odour. On account of these defects the oil has a limited use in the industry. The texture of the seeds also deteriorates during storage making it difficult to allow proper crushing of the seed. Sometimes, deterioration may proceed to such an

extent that most of the oil in the seed gets charred and renders the seed useless.

(2) By proper processing of the fruit consisting of the operations of (i) depulping, (ii) drying, and (iii) decortication, it is possible to produce neem seed which has good keeping qualities and which produces an oil with low free acids, light colour and minimum odour.

(3) It was also found that the seed prepared by properly drying the whole fruit had the best keeping properties. Next in order of keeping properties was the undecorticated seed obtained after properly depulping the fruit and drying the seed. Third in order was the kernel obtained by depulping the fruit, drying and then decorticating it.

The work was then taken up for designing suitable machines for scientific processing of neem fruit.

Under a grant from the Indian Central Oilseeds Committee, the design of the following machines is under progress.

**Depulping:**

**Soaking pits**—Different types of soaking pits have been prepared.

**Depulping**—A small hand-worked depulper with a capacity of about one maund of fruit at a time has been designed and fabricated. It is a cylindrical drum fitted with a stirrer with a suitable type of stirrer-blades. There is an outlet near the bottom of the drum for taking out the charge when the pulp has been detached from the seed. The charge is then transferred on to a sieve of suitable size which can be hung from a tree or a pole. By pouring water on the sieve while the latter is shaken by hand the seed can be washed free from the pulp.

A bigger size power-worked depulper has also been designed which can take a charge of about 10 maunds of fruit. After treating the soaked fruit in this depulper the pulp and seed can be separated in the washing machine.

**Washing machine**—It consists of a vibrating sieve fitted in an inclined position and provided with water spray jets. It can be run by hand or with power. The charge from the depulper is transferred on to this machine. While the sieve vibrates and water from the jets falls on the sieve, all the pulp passes through the sieve along with water and the seed rolls down the sieve and is discharged at the lower end.

**Elevator & Conveyor**—In order to lift the seed from the soaking lanks to the power-worked depulper an elevator and a gravity slope conveyor have been designed. The elevator consists of flat iron discs fixed at short distances on an endless chain, the ascending side of the chain being enclosed in a cylindrical casing. At the top and the bottom special sprocket wheels are provided to move the chain. The flat iron discs lift the soaked fruit from the soaking tanks and deliver it at the top of the elevator from where the material runs down through a gravity slope channel to the depulper. The elevator can be worked by hand at the top wheel.

**Drying :**

The depulped seeds after washing are wet and need drying before decortication. Drying is the most important phase in the whole process of preparing the kernel. The keeping properties depend upon the moisture content of the seed which must, therefore, be sufficiently dried to prevent auto-oxidation and resultant spoiling of the seed. The drying has to be done at a low temperature as high temperatures may affect and even char the oil.

Three different types of small experimental driers have been designed. One is a compartmental tray-drier for direct heating with flue gases. It consists of a brick chamber inside which trays charged with seed to be dried are placed on angle iron supports, one above the other at regular distances. The flue gases from a furnace enter the chamber at the top and pass downwards over the trays in a zigzag way and from the bottom of the chamber pass to the chimney. The amount of fuel to be fed to the furnace can be regulated with a little experience so as to control the temperature inside the chamber.

Another similar chamber has been made with arrangement for passing hot air in place of flue gases over the seed placed in trays. An iron coil is placed in the combustion chamber of the furnace, one end of which is connected to an air blower and the other end to the bottom of the drier where the hot air passes upwards over the trays in a zigzag way and from a vent in the top of the drying chamber it escapes out.

A small hand-driven rotary drier has also been fabricated. It is a cylindrical steel drum placed horizontally on bushes and encased alround. In the lower half it is enveloped by flue gases from a furnace and is rotated by hand. The wet seed to be dried is charged through a charging door in one of the ends. Constant turning of the seed inside the drier helps in its quick drying. The dried seed is discharged through a door provided at the other end.

Three types of furnaces have been designed, one suitable for burning coal or wood and another for low grade fuels such as leaves, stalks, straw and other waste materials available in villages. In the latter furnace even wet material can be used as it dries while it slides down a slopping passage before falling on the grate where burning takes place. A third furnace which has been designed is a lowcost furnace which is partly dug in the ground and can be prepared at a cheap cost and thus find favour for small scale working in the villages.

**Decortication :**

In areas with scanty rain-fall neem fruit as it falls from the tree can be dried in the sun and stored as such. This dried neem fruit also needs decortication to remove the pulp and shell. If the dry fruit is crushed as such the yield is very low and the colour of oil obtained is darker. But in Uttar Pradesh and other places where rains are fairly abundant the fresh fruit has higher moisture content (about 60%) and cannot be sun-dried due to insufficient sunshine. There it is advisable to remove the pulp so that much less water has to be removed during drying. The depulped and dried seed is then decorticated to get the kernel. Two types of decorticators had, therefore, to be devised, one for the whole dried fruit and the other for depulped seed.

To decorticate depulped seed on cottage scale a chakki with upper disc made of wood of suitable weight and having suitable grooves and the lower one of stone has been designed. The kernel has to be separated from broken shell by hand winnowing. For large scale working two grooved rolls moving in opposite direction and worked with power or hand depending upon the size and capacity have been tried. A fan fitted at the bottom separates the kernel from the shell as they fall from the rollers.

For the whole dried fruit a decorticator has been tried having protruding blades fixed on a rotating cylinder which moves against a segment fixed in the casing of the machine having similar protruding knife blades. It is similar to the cottonseed decorticator. Experiments are in progress to determine the most suitable design.

**Pressing of neem kernel :**

Neem kernel can be pressed in village Kolhus. It has been successfully pressed in the improved Wardha Oil Kolhu. Hand screw presses and hydraulic presses can also be used. Expellers have not been found quite suitable for the purpose as the cake does not set and expression is difficult.

The chief object which has been kept in view while designing the above equipment is that the same may be simple and cheap and may not require much technical skill in its working so that the industry may be encouraged in the areas (mainly rural) where neem fruit is abundantly available.

Exploitation of the vast potential resources of neem oil in the country and proper development of neem oil crushing industry and other industries based on it like soap-making, manufacture of neem oil fatty acids and their derivatives is an imperative need of the time. It may be pointed out that All India Khadi & Village Industries Board has prepared a scheme for the collection and utilisation of neem fruit in its programme for the Second Five Year Plan.

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# THE EFFECT OF DIFFERENT HARVESTING METHODS ON THE OIL CONTENT OF CASTOR BEANS (RICINUS COMMUNIS, L)

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Quality studies of the castor beans obtained by different methods of harvest were undertaken by the authors to determine their relative merits and to recommend the most efficient among them.

Fruit clusters of TMV.2 Madras strain of Castor were harvested from a crop grown under uniform conditions of cultivation and handled in three different ways, viz.

(i) Harvesting fruit clusters when one or two capsules on them show signs of drying, drying them in the sun and shelling the capsules for extracting the beans;

(ii) Harvesting capsules as and when they dry on the fruit cluster and shelling them for extracting the beans; and

(iii) Harvesting fruit clusters when one or two capsules on them show signs of drying, keeping them covered and weighted in heap for a week, drying in the sun and shelling for extracting beans.

The beans obtained by these methods were observed for colour and tested for oil, free fatty acids, and field germination. The results clearly show that beans obtained by the first two methods have comparatively high oil content and germination capacity and low free fatty acid contents than those obtained from the storage treated material. Though the beans obtained by collecting capsules as and when they dry on the fruit cluster are as good as those obtained by harvesting entire fruit clusters when one or two capsules show signs of drying and then immediately drying in the sun, still considering the extra labour and cost involved, the former method is not recommended for large scale adoption. The method of harvesting fruit clusters when one or two capsules start drying on them, drying them sufficiently in the sun and extracting the beans is therefore the most efficient and economical method which the growers should adopt for securing good quality castor beans. Growing strains of TMV.2 type with uniform maturity and non-dehiscent capsules is recommended in order to avoid premature harvest and thus collecting castors beans of low oil content.

## Introduction :

Castor (**Ricinus communis, L.**) one of the major oilseed crops in India is mostly grown under rainfed conditions. The plant has more than one fruit cluster, the number depending upon the variety grown. The fruit clusters attain maturity in different stages and consequently their harvests come off at different periods of the crop's growth. The method of harvesting usually adopted is to remove the entire fruit cluster when one or two capsules on it show signs of drying. This is done with a view to avoiding loss of produce by shedding of beans and also the high cost involved in harvesting the fruits as and when they dry up on the fruit cluster.

Another method that is practised in certain areas is to harvest the entire fruit clusters when one or two capsules show signs of drying, heap them, cover the heap with straw or some other trash, weight the materials to exclude air for a period of a week and thereafter dry the produce and extract the beans. This is done to facilitate easy extraction of seeds and also in the belief that this process helps in increasing the oil content of the beans. In order to assess the relative merits of the different practices in vogue and to determine the best method of harvesting and handling castor produce, this study was undertaken.

## Literature Reviewed :

Dr. Watt[1] in his notes on the cultivation of castor in the Indian States describes the various methods of harvest in vogue in Madras, Andhra, Bengal, Orissa, Bhagalpur and North-west Frontier Province. They are almost similar in that the capsules are harvested and stored for about a week and then dried and shelled. Gilbert[2] has stated that "in harvesting, the fruiting branches should be cut off as soon as the pods begin to pop open and this process must be repeated at least once or twice a week as fast as the seeds ripen. The fruits are then spread out to dry." Bailey[3] also observes that "the pods are so constructed as to throw the seeds to a considerable distance when the wall of the pod breaks and hence the necessity for collecting the entire fruit cluster as soon as it turns dark brown. These clusters are cut off with a sharp instrument and hauled away in a tight wagon box. They are then spread on a tight floor in the barn and left to dry and crack open." Timson[4] too has stated that "to avoid shattering, the entire spike should be cut off as soon as the capsules begin to turn brown." The Department of Agriculture of Ceylon[5] and Burma[6] on the other hand appear to recommend to their growers, "the collection of fruits and stacking the fruits for a few days and then exposing to sun and shelling."

Sethi[7] while describing the prevailing method in Uttar Pradesh which consists in gathering recemes even while green and storing them in heaps for three or four days, observes that "the oil content of the castor seeds depends more on the degree of maturity than on anything else. The difference in oil content ranges from 0.86% to 9.54% depending upon the quality of the seed and the degree of maturity." He therefore suggests that "the usual method of harvesting employed by the cultivators which consists of removing the seeds when only a few of the top seeds have ripened, is obviously very faulty and should be stopped and the practice of harvesting unripe capsules can also be avoided by growing only non-dehiscent varieties". But Miller[8] describes "the proper time for harvest as the spikes turning brown and the capsules just beginning to open assuming yellowish colour. The capsules collected are thrown in a heap, covered with gunny for three or four days and when a beginning of fermentation has set in, the capsules have somewhat softened, the heap is opened and dried and shelled." Weibel[9] has not given details about the practices prevailing in the United States of America. He only says that "the spikes are cut or broken off and the capsules are stripped off and unless the capsules are dry, they must be spread out so that they will dry quickly."

Most of these workers excepting Sethi appear to be in favour of harvesting the entire fruit cluster even at the first symptom of a few capsules drying, in order to prevent shedding of beans in the field and also in favour of the storage of the fruit clusters for a short period extending up to a week. In all these cases, the necessity for storage of fruit clusters has been stated to be to make the fruit coat soft by decay and thus render extraction of seeds easy. Sethi only emphasises the need for harvesting capsules at the mature stage. But nowhere has the effect of these methods of harvest and storage of capsules on the quality of the beans such as colour of beans, oil and free fatty acids contents and viability, been studied.

**Materials and Methods:**

TMV.2 an improved strain with medium duration (6½ to 7 months from seed to seed) was raised 3′ apart either way. Plants which came to flowering on the same day were marked out and the capsules from these plants were harvested as detailed below.

(i) Harvesting the entire fruit cluster when one or two capsules on it show signs of drying.

(ii) Harvesting capsules as and when they dry on the fruit cluster.

(iii) Harvesting the entire fruit cluster when one or two capsules on it show signs of drying and keeping them stacked and covered with straw for a week. Thirty plants were selected for each of the above treatments and out of them only twenty were taken for the study, leaving the other ten for any contingency that might arise. For purposes of uniformity only the terminal fruit clusters in the selected plants were harvested in all the treatments. In the first treatment all the capsules of the fruit cluster in each of the 20 selected plants were separately harvested when one or two capsules in each fruit head showed signs of drying. The produce was separately sun dried and the beans extracted. In the second treatment, the capsules from the fruit cluster in each of the twenty selected plants were separately harvested as and when the capsules became dried up and the beans from them were then extracted. In the third treatment, the fruit clusters were harvested as in the first method, stacked in a heap and kept covered with straw and weighted. To give natural conditions and facilitate proper fermentation of the capsules, the bulk crop of the same strain was also harvested in a similar manner and the produce utilised for covering the experimental material inside the heap. After seven days, the stack was dismantled and the experimental fruit clusters sun dried and the beans extracted separately from each of them. For purposes of convenience the above methods of harvest and handling will be referred to as the first, second and third method of treatment respectively in the subsequent sections. The beans obtained from all the three treatments were carefully analysed for their oil and free fatty acids contents, keeping the produce of each plant separately. The ultimate produce was also examined for the colour and the beans were tested for their viability. Summary of analysis of the data on oil and free fatty acids contents is given in the table appended.

## Discussion:

The results of analyses of the figures for oil and free fatty acids contents show that there is significant difference in oil content between the treatments. The first and the second treatments are on par with each other in respect of their oil content (52.42 per cent and 52.36 per cent respectively). But in the case of the third treatment the oil content shows marked reduction (48.58%). In respect of free fatty acids content, the first two treatments show comparatively low percentage (i.e. 0.48% and 0.49% respectively against 0.8% recorded for the third treatment). Judging from both the oil and free fatty acids contents, the results are in favour of the adoption of the first two methods of harvest in preference to the third. The third method definitely results in produce of poor quality. The deterioration in quality of the resulting beans in this case appears to be mainly due to the fermentation that sets in during the process of keeping the material heaped and weighted in storage for a week. This finding is contrary to the belief prevalent among the growers that beans obtained by this method has a higher oil content. It also goes against the recommendations of the Department of Agriculture in Ceylon and in Burma and the method practised in Jamaica as described by Miller.

Gilbert, Bailey and Timson while describing the methods of harvest in castor, have observed that the entire fruit clusters are cut off from the plants even when the capsules are green or when some of them show signs of drying. This method of harvest, according to them, is being adopted merely out of the fear of losing the beans by dehiscence of capsules and popping of the seeds even while they are green. At this stage, the capsules on the top portion of the fruit clusters, particularly in some of the local cultivated varieties would not attain full maturity. According to Sethi, oil content in castor seed depends upon the degree of maturity. In the present study, the first two methods of harvest show similar oil and free fatty acids contents. In fact, harvesting and handling fruit clusters by the first method has given beans with higher oil contents and lesser acidity than that obtained by the second method. In spite of the earlier harvest in the former case, the produce has shown better oil content. This may be attributed to the fact that the improved strain on which the authors carried out the study is characterised by very uniform ripening of the capsules on the fruit cluster. Perhaps in the case of the locally cultivated varieties where the capsules attain maturity gradually in the course of a week or a fortnight, the first method of harvest might result in slightly reduced oil content. Sethi's statement is evidently based on observations carried out with such varieties. That this is so is confirmed by his recommendation where he has advocated the growing of non-dehiscent types to avoid loss by dehiscence of capsules and popping of beans.

The storage of the fruit clusters in a heap immediately after harvest has also been found to effect the colour of the beans to a marked extent. The beans turn black, in which condition, they have a low market value. The percentage of black beans was found to be maximum (45%) in the case of capsules kept stored before shelling, while it was very low (hardly 5 to 7 per cent) in the other two methods of handling.

The storage of capsules in a heap immediately after harvest has also been observed to affect the germination capacity of the beans. It is low (84%) for beans obtained by such storage and very high 95% to 98% for beans obtained by the first two methods of harvest. Besides these differences, another practical difficulty was also encountered in shelling the capsules resulting from material stored in a heap. The shells of the fruits did not separate out and release the beans easily. Pressure exerted for extracting the seeds, resulted in higher percentage of broken beans. In the case of the capsules obtained by the first two methods, no such difficulty was experienced. This again is contrary to local belief that the process of stacking in heap and storing for a week facilitates easy extration of seeds. But it is not possible to say till further tests are carried out with other types, whether the difficulty experienced in extracting seeds from the stored capsules in the present study is due to the non-dehiscent nature of material tested.

## Conclusion:

Based on this systematic study, it may be stated that the castor fruit clusters can be harvested without any loss in yield or adverse effect on the quality of beans either when one or two capsules on the fruit cluster show signs of drying or as and when the capsules on them begin to dry. The latter method, which involves additional labour and cost for harvest will not be economic. As already pointed out, these methods of harvest are adopted owing to the fact that capsules would dehisce even in the green stage and pop off the beans causing loss of the crop. But this can be avoided by growing a strain like TMV.2 castor with non-dehiscent capsules. Even if the first method of harvest namely gathering the fruit clusters with one or two capsules dried up is adopted there is no fear of the quality suffering because this strain has very uniform maturity of capsules. The authors do agree with Sethi in his recommendation for growing types with non-dehiscent capsules and uniform maturity. The practice of storing in heap immediately after harvest and weighting has to be deprecated as it has no special advantage and the resulting beans are also of poor quality as judged by their black appearance, low oil content and germination and high acidity. Sethi has not given any evidence against storage of capsules after harvest. But the results of this study have clearly brought out the serious disadvantages of this widely adopted practice.

## Summary:

Quality studies of the castor obtained by different methods of harvest were undertaken by the authors to determine their relative merits and recommend the most efficient among them.

Fruit clusters of TMV.2 Madras strain of castor were harvested from a crop grown under uniform conditions of cultivation and handled in three different ways. The beans obtained by these methods were observed for colour and tested for oil, free fatty acids, and field germination. The results clearly show that beans obtained by the first two methods have comparatively high oil content and germination capacity and low free fatty acids content than those obtained from the third method. Though the beans obtained by the second method is as good as those obtained by the first method, still considering the extra labour and cost involved, it is not recommended for large scale adoption. So, the method of harvesting fruit clusters when one or two capsules show signs of drying, drying them sufficiently in the sun and extracting the beans is the most efficient and economical method which the growers should adopt for securing good quality castor beans. Growing strains of TMV. 2 type with uniform maturity and non-dehiscent capsules is recommended in order to avoid premature harvest that would result in beans of low oil content.

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## TABLE I.

### Oil and Free Fatty Acids Contents of Castor Beans from Different Methods of Harvest

| Year. | Harvesting the entire fruit cluster when one or two capsules are dry. | Harvesting capsules in the furit cluster as and when they become dry. | Harvesting the entire fruit cluster when one or two capsules are dry and heaping and weighting them. | Whether "Z" test significant or not P =0.05 | Conclusion. |
|---|---|---|---|---|---|
| | | | **OIL CONTENT** | | |
| | | | **(Average [percentage] of 20 plants)** | | |
| 1st year | 51.61 | 51.56 | 49.81 | Yes | $\overline{A, B}$, C |
| 2nd year | 50.15 | 60.04 | 47.50 | Yes. | $\overline{A, B}$, C |
| 3rd year | 55.49 | 55.48 | 48.44 | Yes | $\overline{A, B, C}$ |
| Average | 52.42 | 52.36 | 48.58 | | |
| | | | **FREE FATTY ACIDS CONTENT** | | |
| | | | **(Average [percentage] of 20 plants)** | | |
| 1st year | 0.36 | 0.42 | 0.95 | Yes | C, $\overline{B, A}$ |
| 2nd year | 0.41 | 0.36 | 0.54 | Yes | C, $\overline{A, B}$ |
| 3rd year | 0.56 | 0.67 | 1.11 | Yes | C, $\overline{B. A}$ |
| Average | 0.46 | 0.47 | 0.87 | | |

# PROPAGATION OF KAMALA IN INDIA.

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**The paper gives briefly the method of raising plantations of Kamala tree, Mallotus Philippinensis. the seeds of which are now in great demand for the quick-drying oil which produces the famous wrinkled varnish. This plant occurs as an undergrowth in the moist deciduous forests of Bombay, Bihar, Uttar Pradesh, Bengal and Assam. Since it occurs as an undergrowth in the natural condition, it requires side-shade in the early stages for its optimum development. The method recommended for raising its plantations is by transplanting 6 months old nursery-raised seedlings. The methods of direct-sowing of seed in situ is not safe due to low germination of the seed on account of its oily contents and damage by squirrels, rodents etc.**

It is an evergreen. small, much branched tree forming the understorey of the moist desiduous to evergreen forests throughout tropical India and grows wild in profusion in the forests of Bombay, Bihar, Uttar Pradesh, Bengal and Assam. In botanical terms it is known as **Mailotus phillippinenses** but its simple Indian name is Kamala Tree. It is also often called the "Monkey Face Tree".

Since it is an undergrowth restricted to understorey, the artificial regeneration of the species in completely dry and open spaces without any side shade is not advisable. Shade and moisture are necessary in its early stages as it is sensitive to drought. Fruit is ready for collection during April-May and about 660 seeds weigh an ounce. The seed is to be sown immediately on its collection as it loses its viability on account of its oily nature.

In view of its requirements of shade and moisture one of the methods of augmenting its stocking in suitable parts of forests will be to resort to patch planting or patch sowing in blanks in those forests where it already occurs but is too spare to rely upon.

Regarding technique of planting. the species can be propagated both by direct sowing and transplanting but the latter method is more reliable and sure as the germination of seed is rather uncertain and low in the former method.

**Direct sowing :—** In case of dibbling in situ. in forests. four seeds should be sown by May end at each stake (spaced 2' x 2'), after loosening the soil at each dibble. It should be noted that the red triangular capsule is the fruit and not the seed. It contains three seeds inside which should be separated carefully into three parts of the fruit without taking out the small oily kernel (seed) inside. These signleseeded parts of the fruit should be sown as they are and lightly covered with about ¾" layer of soil. The seed is liable to be eaten by rats and insects and should be covered well, but not too deep. Germination begins in about three weeks and continues for some time. Regular weeding and loosening of the soil should be carried out during the first two years and as often as may be necessary afterwards. The species is not readily browsed by goats and cattle and some protection from trampling only of the cattle is necessary.

However, the method of propagation by direct sowing of seed is not considered to be fully successful on account of its low power of germination due to oil content in seed, and heavy attack of squirrels, rats, etc. Transplanting of nursery-raised seedling is therefore the safest method.

**Transplants** :—As **Mallotus philippinenis** is a dioecious plant i.e. male and female are two separate individuals, it is necessary to have a close spacing in case of pure plantations in order to have maximum number of fruit bearing female seedlings. An initial spacing of 3' x 3' is therefore recommended for planting of about 6 months old nursery raised seedlings. A close spacing is also advisable as the growth of this species is comparatively slow. Later on, the plants can be thinned, if found congested, after 3-5 years' growth. For getting transplantable size of seedlings in rains, fresh seeds should be sown in April, or as soon as they are collected, in nurseries and lightly covered with earth. Nurseries should be kept shaded, watered and weeded regularly. The more vigorous seedlings should be transplanted in the beginning of coming rains in June while the smaller ones may be retained in the nursery for transplanting in the following year. Large-sized seedlings can also be stump-planted.

**Mallotus Phillippinensis** trans planted in 1951 rains under partial shade in Haliyal Research Garden.

Photo : I. M. Qureshi. Date : 28-12-1952.

Seeds will have to be sown a year in advance of planting in nursery beds in order to get the required stock of transplantable size. Photograph No. 1, depicts the successful experimental plantation of the species under partial shade at Haliyal Research Garden where the average height is over 2′ within 3 years.

Kamala tree is by no means an obscure or unfamiliar tree for those interested in the wealth of plant life in this country and is particularly noted for the Kamala dye got by pulverising the red shell of the Kamala fruit. The Kamala dye is famous for the durable and rich orange hue it imparts to silk textiles. It is also known for its medicinal properties and as a remedy for tape worm.

On account of the recent discovery as a substitute to the imported tung oil it is gaining commercial importance. The Kamala fruit contains black seeds which yield an oil of yellowish brown colour. It has been found that the oil has very good drying properties and is in every way comparable to tung oil produced largely in China. Kamala oil leaves wrinkle finish when sprayed on any object. A remarkable thing about the newly discovered wrinkle finish substance is that no special drying process is involved, it is air dried. Sprayed on **aluminium and unmixed** with any colour the Kamala varnish leaves an exquisitely wrinkled golden luster. The varnish can easily be mixed with any colouring pigment so that one can obtain a wrinkle finish effect in any hue on objects like paper, cloth, metal, masonite boards or house walls.

# EXTRACTION

# PRETREATMENT AND PROCESSING OF COTTONSEED

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Central Laboratories for Scientific and Industrial Research, Hyderabad. (Dn.)

**The processing of cottonseed to recover all the useful products like linters, hulls, meats, etc. in India is of recent origin. Though not followed on lines similar to that in America or elsewhere, it is gradually progressing with the growing realisation of the scientists and the industrialists in the importance of cottonseed industry.**

**There has been practically no work on this aspect and no data are available. Since Indian cottonseed differ much from American varieties it becomes necessary to study the conditions and the factors that affect the processing. With a view to collecting data regarding the various adjustments, power consumption and the corresponding yields of products like linters, hulls, oil, etc., a local commercial variety of cottonseed was taken up for studies on a pilot plant installed at the Central Laboratories.**

**Detail working difficulties, power requirements and the economic of processing have been discussed both in regard to the pretreatment of cottonseed and the expelling of the meal. The refining data are also discussed.**

India is one of the major producers of cottonseed in the world and Hyderabad State contributes about 15% to India's total production. The recent figures for production (1, 2, 3) of cottonseed for India and Hyderabad are given in Table I.

**Table I. Cottonseed Production**

| Year | India | Hyderabad. |
|---|---|---|
| 1949-50 | 920,000 tons. | 114,000 tons. |
| 1950-51 | 1,018,000 „ | 106,200 „ |
| 1951-52 | 1,096,000 „ | 175,400 „ |
| 1952-53 | 872,000 „ | 129,000 „ |
| 1953-54 | 1,145,000 | 165,000 |

The Marathawada and Karnatak regions of Hyderabad are the main cotton growing areas of the state, supplying about 90% of the cottonseed production in the State. (3).

Even now most of the cottonseed grown is fed to cattle as such. This is a wasteful practice, as a variety of useful products like linters, hulls, oil and cake can be obtained by processing the cottonseed. Cotton linters are the main raw materials for the manufacture of rayon, gun cotton, good quality paper, surgical cotton etc. It may be of interest to point out here that one acetate rayon factory, M/s. Sirsilk Ltd., situated in Hyderabad State, requires about 5 tons of cotton linters per day for its normal production. The indigenous cotton linters meet only a part of its requirements, the balance being imported. At present the hulls in some cottonseed processing plants are used as fuel. They could be better utilized as roughages in cattle feed, soil conditioners and for the manufacture of useful chemicals like furfural, active carbon, etc. The oil after refining could be used for edible purposes, either as refined oil or as vanaspati after hydrogenation. The cottonseed cake could be used as cattlefeed.

There are about 40 oil mills in India which crush cottonseed, of these, only 4 or 5 have complete processing units. In Hyderabad there is one such modern plant having a capacity of about 25 tons per day, managed by M/s. B. Kishanlal & Co.

Recently, the Central Laboratories for Scientific and Industrial Research, Hyderabad have installed a complete plant for the pre-treatment of cottonseed.

The pretreatment of cottonseed comprises cleaning the seed, removal of linters from the seed (delinting), hulling of seeds and the separation of hulls from meats. Cleaning is essential to remove the foreign matter usually associated with the seed. This is achieved by employing safety shakers and the pneumatic principle. The unit installed in the Central Laboratories for pilot plant experimentation is a safety shaker. The delinting is done using linters having either 141 or 176 saws. The unit in the Central Laboratories has 141 saws, for the "filing" and gumming of which a Wood's Duplex Rotary Gin Saw filer Gummer No. 14x has also been procured. Hulling is done either by disc huller or bar type huller, the latter being superior because of the lesser possibility of the loss of oil during this operation; the huller installed at Central Laboratories is of this superior bar type. Complete separation of hulls, meats and uncut seeds is accomplished in three units, namely the shaker separator with a nozzle, the hull and seed separator and the rotating drum tailings beater. All these units are installed in the Central Laboratories.

**Need for pilot plant work on pretreatment:**

Indian cottonseed is somewhat different in composition from American seed. There is a wide variation in the size of the seed and the content of the linters (4). The different varieties of cottonseed grown in India could be broadly classified into two groups, one having high linter content and of high seed index, and the other having low linter content and of low seed index.

There are no data available regarding the yield of various products, their quality, the conditions under which optimum yields could be obtained, the power requirements at various stages of the processing, etc. It is not possible for an industry to undertake such work although they will be directly benefited by such data. A research institute like ours is well suited to take up this type of experimental investigations on a pilot plant scale. It was with a view to collecting such data on a pilot plant scale and thus being in a position to help the institution of cottonseed industry, that pilot plant studies were undertaken by us.

The pilot plant work was undertaken in co-operation with a local company, M/s. Aryan Industries, Secunderabad, who supplied about 20 tons of the commercial variety of cottonseed. The seed was a mixture of the high-lintered and the low-lintered varieties in the approximate proportion of 3 : 1. The analysis of the sample, compared with these two varieties, is given in Table II.

### TABLE II.—ANALYSIS OF COTTONSEED.

| Variety | | Moisture | Linter content |
|---|---|---|---|
| Commercial (mixture) | ... | 7.95% | 10.86% |
| Low-linter | ... | 7.73% | 4.31% |
| High-linter | ... | 7.43% | 13.15% |

Studies were made with various adjustments & the following data were collected: (i) loss during cleaning of seed, (ii) yield of linters during first cut, second cut and mill run, (iii) loss during delinting, (iv) time and power requirement, (v) residual lint on seed, (vi) effect on the above of changing the feeder rate and the index number on the seedboard, (vii) the yields of hulls and meats, (viii) the quantity of hulls and meats, and (ix) the time power requirement for hulling and separating.

The summary of the yields are given in Table III.

### TABLE III.—YIELDS OF PRODUCTS.

| | |
|---|---|
| Linters ... ... ... | 5% |
| Hulls .. ... ... ... | 32% |
| Meats .. ... ... | 55% |
| Dust, etc ... ... ... | 8% |

The products were handed over to the supplier of the seeds, who expelled the meats in a Duo Expeller and reported a yield of only about 28% of crude cottonseed oil in the meats. A refining test on the crude oil having an f.f.a. of 3.5% as oleic acid, in our laboratoy gave the following results :—

| | |
|---|---|
| Refining loss | 9.35% |
| Lovibond Colour of refined oil in 1″ cell | 20 Y, 2.5 R |
| Lovibond Colour of bleached oil in 1″ cel | 2 Y, 0.3 R |

The analysis of the cake was done in our laboratories and the following were the results:—

| | |
|---|---|
| Moisture and volatiles | 6.34% |
| Oil content | 5.92% |
| F. F. A. of the extracted oil | 2.78% as oleic acid. |

Bassed on the data collected, an estimate of the costing for a plant having a capacity of 100 tons of cottonseed per day has been worked out and given in Annexure 1.

Similar exhaustive studies are necessary for other types of seeds, particularly of the low lintered variety which forms the bulk of Indian production of cottonseed.

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## ANNEXURE 1

### COTTONSEED PROCESSING

### Estimate of Costing

**Capacity:** 100 tons a day.

| | | |
|---|---|---|
| Products: | Linters | 5 tons. |
| | Hulls | 32 tons. |
| | Meats | 55 tons. |
| | Dust etc. | 8 tons. |
| 55 tons of meats give :— | | |
| | Crude oil (28%) | 15.4 tons. |
| | Cake | 39.6 tons. |
| 15.4 tons of crude oil gives :— | | |
| | Refined oil (92%) | 14.2 tons. |
| or | Deodorised oil (97%) | 13.8 tons. |
| | Cottonseed foots | 1.5 tons. |

……

| | |
|---|---|
| Plant cost ... ... ... ... | Rs. 16 lakhs. |
| Working capital ... ... ... | Rs. 14 lakhs. |
| | Rs. 30 lakhs. |

**Working cost.** Daily basis 300 days year.

| | Rs. |
|---|---|
| Cottonseed 100 tons at Rs. 220 per ton. ...... | 22,000/- |
| Chemicals at Rs. 9 per ton. ...... | 900/- |
| Power, water and Steam at Rs. 26 per ton. ...... | 2,600/- |
| Wages and Salaries, Rs. 12 per ton ...... | 1,200/- |
| Maintenance, etc. 5% on Rs. 16 lakhs ...... | 267/- |
| **Indirect cost.** | |
| Depreciation 8% on Rs. 16 lakhs ...... | 427/- |
| Interest at 5% on the capital. ...... | 500/- |
| | 27,894/- |

**Returns :**

| | Rs. |
|---|---|
| Linters 5 tons @ Rs. 150 per candy of 784 lbs. or Rs. 428 per ton | 2,140/- |
| Hulls 32 tons at Rs. 80 per ton | 2,560/- |
| Cake 39.6 tons at Rs. 180 per ton | 7,128/- |
| Oil 13.8 tons at (Rs. 20 per tin of 37 lbs.) Rs. 1220 per ton | 16,836/- |
| Foots 1.5 tons at (one anna per lb.) Rs. 140 per ton | 210/- |
| | Rs. 28,874/- |

Net return per day : 28.874
Less : 27.894
Rs. 980
or Rs. 2,94,000 per year.

$$\text{Returns: } \frac{2{,}94{,}000}{30{,}00{,}000} \times 100 = 9.8\%$$

# PROBLEMS OF SOLVENT EXTRACTION INDUSTRY IN INDIA

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**The article deals with various aspects of the solvent extraction industry viz. raw materials, solvents, refining and extracted oil, recovery and by-products and market for the deoiled meal.**

The subject matter is very important due to the fact that in recent times, the Government of India have almost freely given licences for the Solvent Extraction Plants in our country. It is high time that one should think about the main problems facing this new industrial development.

The four problems whose solution is more or less necessary for the successful working of the Extraction Plant are as follows :

1. Raw-material.
2. Availability of the right type of Solvent at an economic price.
3. Refining of Solvent Extracted oil and finding a market for the bye-product.
4. Disposal of the deoiled meal.

Now let us consider each problem in details :—

## 1. Raw-Material :

The Solvent Extraction Plant will have a hard time, however, efficient it may be, if the factory has to depend solely on the outside bazar oil cake as its raw material. In this case, there is absolutely no control in the uniformity of the raw product and hence there are number of problems to be solved in the plant for the successful working of the oil cake. It is really a job to treat in the plant the oil cake, whose previous history is unknown and moreover the quality of the oil cake is changed from time to time. With the oil cakes of different origins and of untraced history, it will not be possible to produce end products of uniform quality. In these days of export, it is absolutely necessary to feed to the plant oil cake of standard analysis and of known constituents in order to get de-oiled meal of high quality.

If we look at the Solvent Extraction Units working in the world today, it will be clearly found out that almost all the plants are treating their own oil cakes. We see that outside bazar oilcake cannot be considered as raw material for the Solvent Extraction Plant.

The Oilseeds which contain oil about 30/35%, should be treated directly in the plant while seeds such as Groundnuts etc. of high percentage of oil should be pre-pressed and then fed to the plant. In short, as far as possible, the Government of India should grant licences to the parties having enough crushing facilities and to those whom they have already granted licences, be given permission to install necessary crushing units. This attitude of Government is urgently required, otherwise Solvent Extraction Plants cannot efficiently function when the prices of vegetable oils fall to a low level, as it was the case in the beginning of the year 1955.

## 2. Solvent :

In my previous paper, I made a passing remark regarding the marketing of the Solvent oil by two big petroleums products dealers of India. At present it is possible to get Normal Hexane of very standard quality (154/158°F) at the price of Rs. 3-12-0 per imperial gallon including the container. The second best solvent available from another dealer is solvent oil of boiling range 62/82°C at the price of Rs. 2-10-9 per imperial gallon inclusive of barrel. Thus considering the price difference and also of the quality difference I would think that 62/82°C solvent oil is quite good. Looking to the high temperature generally prevailing in India, normal Heptane of narrow boiling range is to be preferred to normal Hexane.

The company which is marketing normal hexane is further investigating the possibility of reducing the price from Rs. 3-12-0 to Rs. 3/- per imperial gallon with drum. In this case the product will be quite attractive for the Solvent plants.

At this point I would like to make a passing remark about the cheapest solvent available in the market. The boiling range of this product is 60/120°C and its price is Rs. 1-8-6 per imperial gallon loose; for the comparison, we may take this price at Rs. 2/- per gallon including the drum. The only consideration for the use of this solvent is nothing else but cheap price. With this solvent it is possible to get extracted oil of fairly good quality but the solvent loss is high. Even with high solvent loss, this solvent oil works out to be cheaper than other standard products. Of course, it is a good practice to employ as far as possible, only the best quality solvent in the plant in order to get end products of standard uniform grades. India is one of the most unfortunate countries of the world as regards the price to be paid for the high quality solvent oil and hence it is high time that Government of India should consider the removal of Import Duty on the solvents to be used for extraction purposes. We hope that in near future it may be possible by one of the refineries in India to produce the right type of cut at the most economical price.

## 3. Refining of Extracted oil & Recovery of Bye-product.

The quality of final refined oil is dependent upon the raw material used in the factory. It is easy to produce the first quality refined groundnut oil, if fresh expeller oil cake is treated in the plant. The refining becomes progressively difficult, if the cake treated is very old. In rainy season, the F.F.A. of the oil in the oilcake is increasing day by day and with high F.F.A. we get some type of colouring matter in the extracted oil which is not removed during the process of neutralization, even with fair excess of Alkali. This colour is also not removed in the process of bleaching with activated earth and carbon.

Thus we see that in order to get final oil of acceptable colour, it is absolutely necessary to use fresh oil cake in the process. The second problem and this is very important as far as economics of the process are concerned, is the formation of solid sludge in the tank, in which solvent extracted groundnut oil is stored. This mud is loosely referred to as crude Lecithin. The approximate composition determined in the laboratories is as follows :—

| | | |
|---|---|---|
| 1. | Phosphatides ... ... ... | 25% |
| 2. | Insolubles ... ... ... | 3.5% |
| 3. | Oil ... ... ... | 23.5% |
| 4. | Water (by balance) ... ... ... | 48% |

The main cause for the formation of phosphatides sludge is the phenomenon of hydration taking place in the bottom section of the stripping still of miscella distillation. Here open steam is given to the outgoing extracted oil in order to make it free from the last traces of solvent. Incidentally this steam together with some condenced water are responsible for producing insoluble sludge, which is nothing but hydration of the gummy impurities known as phosphatides.

The main constituents of the phosphatides are Cephalin and Lecithin. It is a great problem how to recover these phosphatides in the form of article of commerce. At the moment, we are burning this mud in our boiler with coal and that too, with some difficulty, because of the mud being very sticky.

There are good prospects of recovering valuable by-products from the mud, if due research work is done. Every year, our plant produce is something like 15/20 tons of mud. Taking the price of phosphatides as Rs. 5/- pound, we loose annually Rs. 66,000/-.

The problem assumes great importance, when viewed in the light that quite a number of Solvent Extraction Plants are in the actual stage of construction. It is high time that some of the research centres in India should seriously take up the problem and put up a stop to such national waste.

### 4. Market for 'Deoiled Meal'.

The last, but not at all least in importance, is the problem for the successful disposal of deoiled cake meal. Five years back, some people in India were not prepared to believe that deoiled meal is as good as oil cake when employed as fertilizer. Most of the groundnut oil cake produced in India is used as manure, but it is not possible to get higher price for deoiled meal than ordinary bazar cake, although the solvent extracted cake contains higher percentage of Nitrogen and that it is in powder form.

Indian deoiled groundnut meal is utilized as cattle feed in U. K. and other parts of Europe, while in our country, we have a controversy as regards the nutritive value of the same as cattle food. The Government of India insist that Mechanical Guards should be provided in the factory in order that no mixing of the deoiled meal should take place with the oilcake, which by chance may be utilised by the cattles of vicinity. At this stage, I would like to refer to the White paper published by the Government of Ceylon on state policy for solvent extraction plants engaged in deoiling coconut poonac. It is the firm belief of the Ceylon Government that deoiled coconut meal is a better feed for the cattle than coconut poonac containing 8/10% oil.

There is a good demand for deoiled groundnut meal overseas, as cattle feed. The Government of India has imposed an export duty on deoiled meal of less than 1% oil to the extent of Rs. 175/- per ton, while the ruling price of ground nut oil cake is only Rs. 130/140. Thus by keeping the export open, Government gains quite a large amount of exchange, most needed for other imports in the country. The price of deoiled groundnut meal is high in foreign market, because there it is used as valuable feed, while it is abnormally low in India as we employ it mostly as cheap fertilizer. The Government should keep the export open on long term basis, just to give good impetus to the newly born solvent extraction plants in India and in return to get money, greatly needed for the Second Five Year Plan. The solvent extraction industry will not be able to make profit, if deoiled cake meal is not allowed to be exported to foreign countries by the Government of India.

It is more than likely to develop export market of deoiled groundnut meal for industrial purposes, such as making gum and protein fibre. Foreign firms may be interested in purchasing white deoiled groundnut powder on percentage analysis of unmodified proteins present in the product, for the manufacture of their protein fibre. Incidentally there is very bright future in India for the production of groundnut protein fibre, when we have to import large amount of pulp for our ever increasing artificial silk yarn's manufacturers. It takes two pounds of deoiled meal to produce one pound of final fibre.

The export duty charged by the Government and freight paid are so high that the price of imported meal overseas, is about 3½ to 4 times the prevailing price in India. Under such circumstances, it is very essential to produce deoiled meal of high protein contents at minimum expenses per Unit of Nitrogen and this is possible only if the Solvent Extraction Plant is to function in collaboration with the Oil Milling section.

# THE COOKING OF VEGETABLE OIL SEEDS

**John W. Dunning.**

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During the last 100 years many men have studied the cooking of vegetable seed. These studies have involved specific methods for cooking as well as the structure of the minute seed cells and the changes in these cells under different cooking and oil extracting conditions. Many of you in attendance at this meeting have not only studied the cooking of the vegetable seed but have, in fact, applied this knowledge in your own mills.

Let us first, then, review the classical reasons for the cooking of oleaginous seeds. These reasons may be expressed as follows:

1. To rupture the oil cells, thus making the oil readily available for extraction.
2. To increase the fluidity of the oil by increasing the temperature of the meats.
3. To destroy the molds, bacteria and enzymes in the meats which otherwise might increase free fatty acid content of the oil as well as harm the meal.
4. To coagulate, set or precipitate the protein fractions of the meats. Some of the proteins in the seed are in a fluid state. Unless they are transformed to a more or less solid state by the cooking process, these proteins will be extracted with the oil thus increasing the foots content of the oil.
5. To coagulate or precipitate the phosphatides in the seeds.
6. To detoxify the free gossypol in cottonseed meats by rupturing the gossypol glands and causing this material to defuse or to become absorbed into the proteinaceous material.
7. To dry the seeds to a moisture content suitable for the specific pressing operation involved.

Following these classical reasons for the cooking of oilseeds there may be stated a classical procedure for the cooking, which would of course, apply to hydraulic press operations. The meats are heated rapidly in the top kettle of a stack cooker to a temperature of 190°F. At the same time the moisture content of the meats is adjusted to 11 or 12%. The meats are then cooked to a final moisture content of 5 to 6% and a final temperature of 225 to 235°F. over a period of time of 80 to 120 minutes.

In developing a specific cooking method for use with the Exsolex process we had two major objectives in mind: (1) A set of cooking conditions that would give the best possible quality of oil and meal; (2) A set of cooking conditions that would make a definate contribution to the process of oilseed extraction, for example, decrease the amount of foots from the prepress Expellers, increase the capacity of the entire operation and aid in flake formation, in preparation for solvent extraction.

Referring again to the classical conditions for the cooking of seed, it becomes apparent that a set of conditions utilizing a relatively high moisture content of the meats, a relatively low temperature in the range of 190 to 210°F, for a short period of time might be specific for accomplishing the requirements set forth except for the last requirement of drying. For example, vegetable cells are ruptured quite often in the presence only of an excess amount of moisture and more readily ruptured if the temperature is increased beyond the normal physiological temperature. Molds, bacteria and enzymes are most rapidly deteriorated at moderate temperatures in the presence of high moisture content. Proteins and phosphatides are coagulated to a porous, absorptive structure only in the presence of moisture. The coagulation of the proteins may be illustrated by the methods of preparing hard boiled eggs, with which you are well acquainted. This method states that the eggs should be cooked at a temperature of approximately 212°F. for six to ten minutes in the high moisture content inherent in the raw eggs. If the raw eggs, on the other hand, were cracked and the yolks and whites cooked at the very high temperatures of smoking fat the proteins of the egg whites tend to lose moisture and brown, thus becoming hard and horny.

With the above reasoning in mind we considered the cooking process as a single set of conditions that should be controlled within certain limits. We assumed that the moisture content during the cooking process should be relatively high so that sufficient moisture would be present for rupturing the oil cells as well as the pigment glands and for coagulating the proteins and phosphatides into an absorptive, fiberous mass. We furthur assumed that the temperature of the cooking process, when conducted at atmospheric pressure should not exceed 212°F. so that there would not be an appreciable evaporation of moisture from the seeds. It was anticipated that this procedure would yield cooked seeds that could be readily dried, that would produce a reduced amount of foots in the prepress Expellers and that would yield an oil of lower in refining loss, and lower refined red colour than normal.

We proceeded, therefore, to investigate the cooking of different seeds at temperatures in the range of 190 to 220°F. at a moisture level of 10 to 15%

for periods of time ranging from 10 to 30 minutes. It was observed that the moisture content of the seeds during the cooking process must be above 11% and preferably above 12%. The temperature need not be above 205°F. and preferably below 212°F. The time of cooking could be varied somewhat in a reverse relation to the temperature. For single pressing a cooking time of 15 to 20 minutes was sufficient. One aspect of the cooking procedures was found to be of prime importance: no over-all moisture loss should be permitted during the cooking operation. We should like to define cooking, therefore, as the processing of oilseeds at a temperature of 200 to 205°F. for a period of 15 to 20 minutes with a moisture content of the seed not below 12%. The cooked meats may then be dried at 230 to 250°F. in any suitable equipment to the moisture levels desired. In applying this set of conditions to the cooking of cottonseed meats in the Exsolex Process it was found that the foots production was decreased, the Expellers had a higher capacity at a given motor load and the product oil had a lower refining loss and a lower refined red colour. This has also been the results with other oil seeds.

As an example, prepress oils of 1.2% F.F.A. from an Exsolex Process operation have given refining loss tests of 3.2% when refined by the regular hydraulic method. The Lovibond red color of the refined oils have been in the range of 4.5 to 5 and the Lovibond red color of the bleached oils in the range of 1.4 to 1.6. Cottonseed meals produced from these operations have contained from 0.03 to 0.05% gossypol.

It is apparent from this definition of cooking that the cooking of oilseeds is preferably done in a single vessel, wherein the temperature and moisture conditions may be readily controlled. For this reason The V. D. Anderson Company has designed a specific and single vessel for the cooking of oilseeds. A second and integral unit is then provided for drying the cooked seeds to the most favourable moisture content for the Expeller operation.

In summary, most vegetable oil seeds lend themselves to the cooking process, especially the major ones, such as peanuts, cottonseed, flaxseed, sunflower seed and castor seed. There are exceptions however, among which are copra and sesame seed which are processed by drying only.

# DEVELOPMENT OF ALCOHOL EXTRACTION OF OILS FROM RICE BRAN AND COTTONSEED.

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This newer process is well adapted for vegetable oil extraction in India where alcohol is an abundant by-product of the expanding Sugar Industry. Ethyl Alcohol is an equally effective solvent as the costlier hexane. The indigenous solvent yields better quality oils and extracted meals. The alcohol process possesses definite advantages such as absence of 'fines' problem, rapid extraction rate, low solvent ratio and high extraction efficiency. Extraction, under slight pressure, at 100°-102° C, enables the utilization of industrial rectified alcohol of 94 to 96 per cent strength, also, as solvent for oil extraction of predried materials. The results of pilot experiments are fore-runners of a significant development in the edible oil industry.

## I. PRODUCTION AND ECONOMICS OF RICE BRAN OIL.

Rice Bran is produced in rice mills and also during hand-pounding of rice. Estimated output in India of bran annually is over 3 million tons, two-thirds of which is produced at the rice mills. The bran contains 18 to 20 per cent of an edible oil which could be recovered economically by solvent extraction. Development of this industry would supplement the country's production of vegetable oils by 3 to 4 hundred thousand tons of a very nutritious oil.

While rice oil is extracted and used as cooking and salad oil in Japan and U. S. A. since several years, in India no attempts have been made so far to recover the oil which has gone to waste for many years. This was due to the inapplicability of ordinary oil-milling methods and equipment to rice bran.

Pilot experiments in the Central Food Technological Research Institute have proved the feasibility of recovering high grade edible rice oil, by extraction with indigenous commercial industrial or power alcohol. It is also found that ethyl alcohol is a cheaper and better solvent to employ in this industry.

**Pilot Experiments :** The method employed has been to mix 40 to 50 lbs. of fresh bran from rice mills with ethyl alcohol and heat the mixture to 100-120° C in a batch pressure extractor during 15 minutes and remove the extract. Four extractions recover 93 to 94.8 per cent of the oil in bran. The extracts were cooled and evaporated to recover two grades of oil which were refined separately. The extracted bran was freed from solvent which was recovered and the dry bran was collected. The total time for a complete cycle of extraction was 4 hours. Improved economy resulted from drying the bran prior to extraction and by using power alcohol. Thereby, less solvent was needed in the process and regeneration of solvent was more economic.

The method of alcohol extraction has the additional advantage that it yields a high quality edible oil and extracted meal. The commonly used solvent-hexane or petrol fraction, has the disadvantage of being very much costlier in India and of recovering an inferior grade of oil. Hexane is quoted at Rs. 3/4/- to Rs. 3/12/- per bulk gallon at the Ports.

**Location of Extraction Plant**: Rice bran tends to become rancid by development of acidity, if allowed to be stored for some hours and consequently the yield of edible oil from the bran, is reduced. Therefore, it is essential to extract the bran as quickly as possible, within 3 to 8 hours, after it is produced in rice mills. The extraction factory has therefore to be located in the neighbourhood of rice mills, and the fresh bran brought in quickly by lorries.

**Effect of Seasonal Production on Plant Capacity**: By a survey of seventeen rice mills in Mysore, it has been ascertained that about half the annual crop of the paddy is hulled soon after the harvest, during four months, viz., December to March and the other half of the crop is stored and gradually hulled during the rest of the year. Thereby, the bran extraction factory would have to work 24 hours during three or four months after harvest and reduced hours—about twelve hours during the rest of the year. But, it is observed that throughout the year for about 300 days, excluding Sundays, the rice mills are at work though with reduced outputs. The programme of bran extraction has to follow the pattern of the neighbouring rice mills. It follows that small batch rather than continuous plants are suited to this indigenous industry.

**Effect of Storage of Paddy on Yields of Bran and Oil:** Experiments carried out during the last fourteen months have revealed that storage of paddy does not adversely affect the yield, condition or acidity of bran. Consequently, the yield and quality or rice oil extracted from the bran are not adversely affected, by storage of the paddy during a year. The proportion of free fatty acids in the extracted oil remains steady and independent of the period of storage of paddy. Consequently, the yield of refined oil is satisfactory both from a fresh crop as well as from paddy stored for a year.

**Yield and Quality of Rice Oil:** The moisture present in bran varied from 8 to 10% according to season and the oil content from 18 to 22%. Extraction of the dried bran by alcohol recovered 93 to 94.8% of the oil present. The free fatty acids in the extracted oil from fresh milled bran ranged from 1.4 to 3% and the oil loss during refining amounted to 15 to 16% of the oil. The refined oil recovered was thus about 75 to 78% of the original oil in bran. The yield of refined oil was 13 to 16% of bran.

Rice oil is similar in chemical composition to groundnut oil. It is light yellow-brown in colour but it may also be light green due to chorophyll. The raw oil has a slight smell reminescent of bran. Alcohol extracted rice oil is a valuable edible oil since it contains tocopherol or vitamin E whose proportion varies from 0.03 to 0.1%. Several nutritional and therapeutic benefits of vitamin E have been observed but the full value of rice oil has still to be appreciated.

Rice oil tends to become cloudy when it is cooled and it regains transparancy when rewarmed. It may be used in the tropics directly as a cooking oil. It may be winterised if necessary. It can also be hydrogenated to produce semi solid oils of desired specifications.

Rice oil with high acidity has been found suitable for making soaps and for making fat-liquor for the leather industry.

Rice oil would find a ready export market on account of its many valuable dietic properties.

**Extraction by-Products :** Rice wax finds use in polishes, emulsifiers and in other industries. Sugar syrup is rich in natural vitamins of B group and finds use in dieteic preparations.

Rice soap makes a useful laundry and toilet article. Fatty acids may be distilled and find industrial uses. The extracted bran contains 1.5 to 2.0 per cent oil and is used as cattle feed.

**Economics of a Batch Extraction Plant:** The plant for a place like Mysore with some 20 rice mills in an area of three miles radius would have a recommended capacity of 10 tons of bran per day. The factory working 300 days in the year, would work 24 hours daily, from December to February and only 12 hours from March to November. The total bran treated would be 1,650 tons in the year with an output of 230 tons of oil. The economics of such a plant are shown below as an estimate:

**Plant cost:** Rs. 5 lakhs.

**Process cost:**

| | | Rs. |
|---|---|---|
| **Direct** | Solvent Alcohol (initial and replacement) 8.000 gallons at Rs. 2/- per gal. ... ... ... | 16.000 |
| | Steam—3.300 tons at Rs. 5 per ton ... ... | 16,500 |
| | Electricity 320 KWH/ton=1650 x 1/8 ... | 2,475 |
| | Water, 4,000 gallons/ton, 1650 x 4/- ... ... | 6.600 |
| | Labour ... ... ... | 14,425 |
| | | 56.000 |

**Indirect:**

| | | |
|---|---|---|
| Plant Depreciation; Insurance | ... | 30,000 |
| Miscellaneous; overheads | ... | 4,000 |
| | Total: | 90,000 |

| | | | |
|---|---|---|---|
| **Material Cost:** | Bran, 1650 tons x Rs. 100 per ton | ... | 1,65,000 |
| | Process | ... | 90.000 |
| | | Total: | 2,55,000 |

**Products Value:**

| | | | | | |
|---|---|---|---|---|---|
| Refined Rice Oil | 230 tons | @ | Rs. 1,100 per ton | Rs. | 2,53,000 |
| Rice Wax | 11.5 ,, | @ | Rs. 2,000 ,, ,, | Rs. | 23,000 |
| Soap | 46 ,, | @ | Rs. 500 ,, ,, | Rs. | 23,000 |
| Sugar | 46 ,, | @ | Rs. 500 ,, ,, | Rs. | 23,000 |
| Extracted Bran | 1150 ,, | @ | Rs. 100 ,, ,, | Rs. | 1,15,000 |
| | | | Total: | Rs. | 4,37,000 |

**Profit:** Rs 4.37 — 2.55 = 1.82 lakhs

**Dividend on Capital:** — 1.82/5.0 = 36.4 per cent.

**Comparative Extraction with hexane:** (costs **Hexane** — Alcohol) **Difference**

| | | | | | |
|---|---|---|---|---|---|
| **Process Costs:** | Solvent | 8000 gallons x 3/8/- =28.000 | plus | Rs. | 12,000 |
| | Steam | 1980 tons x 5/- = 9,900 | — | Rs. | 6,600 |
| | | | plus | Rs. | 5,400 |

**Products Value :**

Sugar — nil — Rs. 23,000
Extracted Bran — 1196 tons x 100 = 1,19,600 + Rs. 4,600 } — 18,400

**Nett Difference** would be a reduction in profit of Rs. 23,800 by the employment of imported hexane as solvent in place of indigenous alcohol.

**Conclusion:** It has been proved conclusively by the pilot experiments that indigenous ethyl alcohol extracts edible rice oil from bran, competetively and the extraction industry is assured of success by a rational development in appropriate rice-milling areas.

## II. PRODUCTION AND ECONOMICS OF COTTONSEED OIL

Edible oil is obtainable from more than a million tons of cottonseed produced in India. The extraction of the oil by conventional crushing of the seed kernel in screw presses produces a dark red coloured oil which has to be refined and bleached to a light coloured edible oil. The intense colou is fixed in the oil on account of the elevated temperatures produced in the screw presses. On the other hand, solvent extraction of the seed kernel at comparatively low temperature yields a light coloured oil. This is especially so, with the employment of solvent ethyl alcohol. Commercial industrial alcohol and power alcohol have been used as solvent.

Whereas imported hexane or solvent petrol is priced at Rs. 3-12-0 to Rs. 3-4-0 per gallon, indigenous ethyl alcohol is priced at Rs. 2 per gallon.

The quality of extracted oil is better with alcohol as solvent than with petrol as solvent since the latter remains in traces in the oil and its odou is persistent until the oil is deodourised by a costly process.

The quality of extracted cottonseed meal is also better with employment of alcohol as solvent, for alcohol dissolves the toxic gossypol from the seed kernel and the extracted gossypol is removed from the oil during refining. The presence of moisture in alcohol, helps in complete binding of the remaining gossypol in the meal, when the extracted meal is finally heated to desolventise the meal. The absence of free gossypol in the alcohol extracted cottonseed meal, makes the latter a better feed for animals. But the petrol extracted meal has to be subjected to a cooking process to detoxify it.

**Alcohol Process:** The cottonseed was delinted, crushed and dehulled by removing the hulls in suitable sieves to obtain the kernel, which contained 30% oil and 10% moisture. The kernel powder was dried to a low moisture content of 1.5 to 2 per cent. It was then extracted with alcohol, in a batch extracter, five times, in batch periods of 30 minutes each, with a solvent to material ratio of 5 or 6 to 1. The extracts were processed to recover the dissolved oil, in two grades, the phase separated and solvent evaporated oils. The extracted meal was desolventised, dried and collected. 90 to 95 per cent of the oil in seed was extracted. Overall refining loss of the oil was 15 to 16 per cent so that the refined oil amounted to 75 to 80 per cent of the original oil in seed.

A by-product of the process is a crude sugar which may find industrial uses.

**Economics:** Since ethyl alcohol is the cheaper solvent in India and is abundantly produced, it is preferred for extracting cottonseed oil. The yield of refined, edible oil is not less than with any other solvent. It is therefore quite an economic method. The quality of the extracted cottonseed meal being better, the meal may be sold as an acceptable cattle feed, more easily than pressed cottonseed cake.

The process requirement of steam is estimated to be more than that in hexane extraction but this is compensated by the lower cost of sovent alcohol.

The semi-refining of oil, in the alcohol process, reduces the cost of subsequent refining and avoids the necessity for bleaching to obtain the edible oil.

**Conclusion**: The setting up of solvent extraction plants using indigenous alcohol, to extract edible cottonseed oil, is a necessary step in the rational utilization of cottonseed produced in the country. The plant and equipment can be imported partly and most of these could be fabricated in India to meet the needs of the industry.

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# DEVELOPMENT OF COTTONSEED CRUSHING INDUSTRY IN THE SECOND FIVE-YEAR PLAN

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India produces approximately 2.2 million tons of groundnuts, out of which nearly 1.3 million tons are being crushed in expellers to-day the balance being taken care of by ghani crushing, export, sowing requirements and direct edible use. Under the Second Five-Year Plan, the target for groundnut seeds production is placed at 2.7 million tons. It has further emerged after the conference convened by the Planning Commission on 25th June 1955 for development of oil crushing industry in the Second Five-Year Plan, that the Government is seriously considering :—

1) freezing, at present levels, the expelling capacity of large scale groundnut seed crushers, coming under the Industries Regulation Act and diverting increasing amounts of groundnut seeds to ghanis;

2) reducing the crushing of groundnut seeds in expellers gradually from 1.3 million tons to a mere 0.7 million tons;

3) diverting gradually the existing idle expeller capacity, and the additional capacity that would be released by the above measures, to the crushing of cottonseeds which will be available in increasing quantity.

The target for cottonseed production under the Second Five Year Plan is placed at 2 million tons out of which approximately 1 million tons is expected to be crushed.

The above fits in with the views expressed by the Nutrition Advisory Committee of the Indian Council of Medical Research and the Animal Nutrition Committee of the Indian Council of Agricultural Research in their joint memorandum on "Human Nutrition vis-a-vis Animal Nutrition" in which they state that 50% of cottonseeds could be safely crushed without impairing animal nutrition in the country.

Although the target set for groundnut seeds production looks impressive, as the investment in the Second Five Year Plan progresses, the purchasing power of the people is bound to improve. What may be now considered as surplus of groundnut seeds would then turn into real deficit as demand for crude groundnut oil and seeds for direct edible purposes increases. Under such circumstances, it would be increasingly difficult for Vanaspati manufacturers to compete with direct edible demand and they will have to slowly turn their attention to an alternative source of edible fat which is not consumable in crude form and has to be processed before it can be put to any edible use. This will not only keep their refineries working but also help reduce their idle Vanaspati capacity which is planned to be fully utilized under the Second Five Year Plan.

Another point of view presented by the protagonists of "Use Groundnut Oil for direct consumption" is that the Vanaspati industry in time to come should allow crude groundnut oil for direct edible use and turn its attention increasingly to an edible fat which requires preliminary processing. They contend that Indian crude groundnut oil is relatively low in FFA and therefore is ideally suited for direct use. They further maintain that the absence of Vanaspati manufacturers from groundnut oil market will have a salutary effect on the price level of this oil which will then be within easy reach of the consumer who has limited purchasing power and will lead to an increased consumption of fat so badly required in the Indian diet. Therefore, considering all the different views, it seems quite inevitable that the future of Vanaspati is closely linked up with the development of cottonseed crushing industry in the country, and it is no wonder that Government's ideas are slowly but definitely moving in this direction.

The present export policy of the Government in regard to free export of cottonseed oil, though commendable for immediate and rapid development of cottonseed crushing industry, cannot be expected to continue indefinitely. Sooner or later, the whole situation will have to be reviewed in the light of the foregoing considerations. The Government's aim in the long run will have to be to process in this country as much crude oil as possible thus allowing export of only fully refined liquid as well as hardened vegetable oil. This will, as already pointed out, help to reduce the idle refining and Vanaspati capacity in the country. It will also give increased employment to the people and bring additional benefit to the Indian exchequer by way of higher priced for the finished product.

At present both crude groundnut oil and semi-refined cottonseed oil are being exported to the United Kingdom and Europe at low prices where they are further processed and good deal is re-exported to the Middle East, Cyprus, Mauritius and South-East Asian countries which are nearer to India. A vigorous attempt to capture these markets for our fully processed product will have to be made in due course by way of developing Export Promotion Councils, etc., as is being done in the textile field today. The matter is not one for complacency and should be taken up forthwith so that a modest beginning made now for export of processed oils will yield rich dividends in the long run.

Turning to the question of the cottonseed crushing industry in the Second Five-Year Plan, a further study of the problem will readily show that this industry, with the Government's present encouragement, will develop itself into two distinct sectors:—

(1) that of organised cottonseed crushers who will have to set up their mills with up-to-date machinery for delinting, decorticating and crushing to get the best results and maximum benefit to the industry. This sector will have to think only in terms of crushing cottonseeds on an year round basis and aim at producing a direct edible product either for the home market or for export;

(2) that of small scale crushers (the so-called general-purpose small-scale mills) who will crush cottonseeds on a purely seasonal basis, and keep their mills running on other oilseeds during the rest of the year. Their main aim would be to cut down their idle time thereby reducing the overheads to the minimum. This will enable them to successfully compete with large-scale mills who have the benefit of lower production costs on account of their improved manufacturing technique and large-scale production.

Due to the essential seasonal nature of their crushing, the small scale crushers will neither be able to invest heavily in cottonseed crushing equipment like delinting and decorticating machinery nor will they be in a position to instal a modern refinery employing trained and highly paid technical staff for refining crude cotton oil. In other words, the small-scale crushers will necessarily have to crush cottonseed of the Desi type which is predominant in India, and offer only crude cotton seed oil to vanaspati manufacturers and/or specialised refiners. This practice is very common in U.S.A. where individual refining is almost unknown and all crude cotton seed oil is processed in large-scale refineries strategically located in consuming areas.

Further, having no delinting machines, it would not be advisable for these crushers to crush American type seed. The presence of linters would make crushing not only difficult but also cause considerable loss of oil in cake by absorption. From the national point of view, this is most undesirable as it would entail loss of valuable linters and oil to the country. Therefore, any incentives to be provided to this sector during the formative period should be so designed that small-scale crushers are, on the one hand, encouraged to crush Desi seed and, on the other, discouraged from crushing the American 'fuzzy' variety. The crushing of American type seed should be done, as far as possible, by those who have complete equipment for recovery of linters in the organised sector. This could be easily achieved by putting a total crude fibre limit in the undecorticated cottonseed cake to be exported out of this country. This measure will mean that crushing and export of American type seed will be possible only if the seed is delinted prior to crushing, while export of undecorticated cake from Desi seed will remain unaffected. If the above policy is adopted, small-scale crushers will naturally have to concentrate their attention on Desi seed, and the American variety will be channelised to those mills which have delinting equipment thereby assuring maximum production of linters in the country. Once this is accomplished, the quality of our exports of undecorticated cake will also steadily improve and fetch a much better price.

Thus, as already pointed out, for the rapid development of this industry in the small-scale as well as organised sectors, the pre-requisites are:—

(i) Trading in crude cottonseed oil to be developed rapidly.

(ii) The total crude fibre content for export of undecorticated cottonseed cake to be fixed at a suitable level so that undelinted undecorticated cake produced from American type cottonseed will not satisfy the standards laid down for export.

So far, the crude cottonseed oil trade is totally absent in this country. All these years, a few Vanaspati manufacturers have been demanding only semi-refined cottonseed oil and thereby they have been able to kill two birds with one stone:—

(1) **They have done away with the handling of crude cottonseed oil soapstock:**—It is common knowledge that crude cottonseed oil is red in colour and the soapstock obtained during semi-refining is deep chocolate. It cannot be easily utilised for making even cheap grade soap unless it is further processed and refined. This processing involves repeated washings by alkali and hot water to turn it into relatively lighter coloured soapstock which can be then used in making cheap grade soap. The only other way of reclaiming this product is to convert it into fatty acids and then distil it under vacuum to obtain very light coloured products which have wide industrial application. But all this requires further investment and effort. By demanding only semi-refining cotton oil, the vanaspati manufacturers have successfully got rid of this headache. This is not in the larger interest of this industry however. In order to develop the production of crude cotton seed oil in the country, small-scale crushers, without any heavy investment, should be able to produce this oil in their existing mills and supply the same to Vanaspati manufacturers and/or large scale refiners who are best suited for processing the same on most scientific lines to produce high grade cottonseed oil and soapstock. Thus the development of trade in crude cottonseed oil would automatically induce the rapid growth of the cottonseed crushing industry in the country. It is highly regrettable that, even today, this point of view is not fully understood and appreciated by those interested in this trade.

(2) **They have monopolised the cotton seed oil trade:**—Since the small-scale crushers are employing only low pressure expellers, there is hardly any

danger of fixing the colour in the crude cotton seed oil in the expelling operation. It is our firm opinion that the maximum damage that is caused today to the semi-refined oil in India is not in the process of expelling but in the indiscriminate semi-refining of the crude cottonseed oil resorted to by individual small-scale refiners due to ignorance and lack of proper equipment and scientific know-how. The general complaint today, both in the internal and export markets, is that Indian semi-refined cottonseed oil is very difficult to bleach and does not respond to the usual methods of bleaching.

The deterioration in bleachability of Indian semi-refined oil is, to a considerable extent, due to the high standard specified for the colour of washed oil without fixing bleachability standards. The small scale crushers, who have very limited resources for semi-refining cottonseed oil, in their anxiety to reduce refining losses and yet produce light coloured oil demanded by the trade, are resorting to partial bleaching thereby seriously affecting its bleachability.

As a result, Indian vanaspati manufacturers on the whole are finding it difficult to utilise Indian semi-refined cottonseed oil to the extent of more than 10% in their product without affecting the colour of vanaspati. This has automatically prevented small-scale vanaspati manufacturers from going in for cotton seed oil because, individually, their production of vanaspati is very limited, and 10% by its weight is too small a quantity worth bothering about. On the other hand, even a 10% requirement of the large-scale producers is quite substantial and gives them sufficient interest in the product. The net result of this has been that small-scale Vanaspati manufacturers, who form an important sector of the processors, are completely out of the market for cottonseed oil and, in the absence of exports, the entire field is monopolised and is at the mercy of two or three large-scale vanaspati manufacturers in the country who dictate their own price for the washed oil. In the past, when there were no free exports, there have been occasions when washed cottonseed oil was quoted at a discount of more than Rs. 100/- per ton below crude groundnut oil in the Bombay market although, in intrinsic value, it is worth more than crude groundnut oil. Under these circumstances, the Indian cottonseed crushers were forced to seek export for cotton seed oil and the Government has come to their timely help by allowing free export since March this year.

In our opinion, in intrinsic value, **good quality crude cotton seed oil** is slightly below crude groundnut oil, and washed cotton seed oil, if properly processed, is Rs. 60/80 above crude groundnut oil. This can be readily seen from the fact that, in England, home produced washed cottonseed oil always sells at £6 to 7 above crude groundnut oil. On the other hand, the Indian washed cottonseed oil at present is selling at a discount of £2 to 3 per ton as compared to crude groundnut oil on account of its poor bleachability. Even so this price is certainly better than what the Indian vanaspati manufacturers were offering at one time.

If the trade in crude cottonseed oil were to be developed in the country, it would be possible for **the Vanaspati manufacturers or specialized refiners** to produce refined cottonseed oil with excellent bleachability under controlled processing. In our opinion, such oil can be used even up to 50% by weight of Vanaspati without producing adverse colour effects. Once this is accomplished, the main objection against cottonseed oil will disappear, and more and more small scale vanaspati manufacturers would go in for this oil. Under competitive demand, the monopoly of the few would be broken and crude cotton seed oil would fetch a fair price. Once this is gradually achieved, there would be no need for the export of cotton seed oil in crude or semi-refined form. From then on, only fully refined liquid as well as hardened cottonseed oil may be allowed to be exported.

It may be worth while striking a note of caution at this stage. While developing the crude cottonseed oil trade, due consideration should be given to the drawing up of proper specifications and bleachability standards for crude oil as is being done in the U.S.A. Otherwise a similar type of prejudice will develop against the crude oil and the future of this industry will be seriously affected. It may be mentioned here that so long as prime quality cottonseeds are crushed at low temperatures obtainable in low pressure 'desi' expellers, there is very little to fear about bleachability. What one has to guard against is the oil produced from off-quality seed and mixing of good oil with mineral oil. For this reason, bleachability standards for crude oil have to be specified to distinguish a good oil from a bad one.

To sum up, for the proper development of the cottonseed crushing industry under the Second Five-Year Plan in the organised and small-scale sectors, crude oil trade based on bleachability standards has to be rapidly encouraged and developed. Once this is achieved, the export of crude or semi-refined products should be gradually discouraged, and the export of only fully refined liquid as well as hardened oils be allowed on a free basis. If these suggestions are implemented, there is no doubt that the cottonseed industry will thrive in this country.

# REFINING

# REFINING OF NEEM OIL

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**A tasteless, odourless and alsmost colourless oil has been obtained by chromatographic purification over alumina column. The physical and chemical characteristics of both the crude and refined oils have been determined.**

Neem or margosa tree (**Melia azadirachta** or **Azadirachta indica**) belonging to the natural order **Maliaceae** is indigenous in India. All parts of the neem tree find application in native medicine (1, 2). Neem oil which constitutes about 45 per cent of the seeds, has been used for centuries in India as a cure for rheumatism, leprosy and skin diseases. On account of its medicinal properties, neem oil and the bitter principles have been investigated by many workers (3, 4, 5, 6).

Although the composition (7) of neem oil suggests that it would be suitable for the manufacture of soap and other products as well as for edible purposes, the bitter taste, bad odour and dark colour of the crude oil have been responsible for its non-applicability for such purposes. Therefore the development of a suitable method for refining neem oil seemed to us to be worthy of investigation.

Watson *et al.* (8) purified neem oil by treating it with concentrated sulphuric acid. Several others (9, 10, 11, 12) have refined this oil by shaking with alcohol. Child and Ramanathan (15) have made a detailed study of the oil. In a review article Mitra (13, 14) has collected relevent information on the purification and utilization of neem oil.

In extending the application of adsorption chromatography for the investigation of the chemistry of lipids, their behaviour on alumina column has been studied. This technique has been tried for the analysis of oils, separation of glycerides, neutralisation of fats and oils and for fractionation of oxidized oils (16).

Kasturi *et. al.* (17), have refined Nahor seed oil by chromatographing the crude oil on a column of alumina. Similarly, in the present study, the crude neem oil obtained by carbon-tetrachloride extraction of a bazaar (Banglore) sample of neem seeds, has been chromatographed on an alumina column using carbon-tetrachloride itself as the eluant and a tasteless, odourless and practically colourless refined oil recovered in good yield. On finally irrigating the alumina column successively with acetone and methyl alcohol, the non fatty material adsorbed on the column was recovered as a pasty solid. This is considered to be the bitter principles. Possibility of the application of the chromatographic technique for the isolation of the bitters from neem oil having thus been indicated, a systematic study has been undertaken.

A comparision of the characteristics of the crude and refined samples (vide table I) would indicate that, excepting for the beneficient removal of the bad qualities of the oil, the chromatographic processing on alumina has not brought about any deleterious effect on the fatty part.

## EXPERIMENTAL

### Extraction of the Oil :—

Soxhlet extraction of neem kernels (355 g.) obtained by decorticating a bazaar (Banglore) sample of neem seeds (880 g.) with carbon-tetrachloride for

30 hours gave a dark red, very bitter and malodorous crude oil (150 g.) in 42.26% yield on the weight of the kernel.

**Refining of the Oil :—**

The above crude oil (50.6 g.) dissolved in carbon tetrachloride was adsorbed on a column of B. D. H. brand chromatographic alumina (500 g.) and the oil eluted out with the same solvent till no more oil came out. The oil recovered from this elute was similarly processed once more on a fresh alumina (500 g.) column when 48.9 g. (96.6%) of a tasteless, odourless and almost colourless oil was obtained.

TABLE I.

Characteristics of the crude & refined neem oil.

| Characteristics | Crude oil | Refined oil |
|---|---|---|
| Specific Gravity @ 24°C. | 0.9188 | 0.9178 |
| Refractive Index @ 24°C. | 1.4698 | 1.4692 |
| Saponification value. | 199.8 | 200.2 |
| Iodine value (Wij's). | 70.09 | 69.11 |
| Acid value. | 4.81 | 2.97 |
| Optical rotation ($CHCL_3$) | +1.096 | Nil. |
| Unsaponifiable matter. | 2.41% | Nil. |

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# THE EFFECT OF ALKALI EXCESS ON THE REFINING OF COTTONSEED OIL

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**The AOCS standard refining method for Cottonseed oil, the "dry" method, was compared with a "wet soap" method in which warm water was added after "dry" refining in order to keep the soap in solution. Filtration of crude oil did not affect its colour after refining by the "wet soap" method. Refining losses using excess alkali by the "wet soap" method reached a maximum and then remained constant, but tended to rise steadily by the "dry" method. Refining losses by the "wet soap" method was some 0.5% lower than by the dry method under optimum levels for each, but the colour of refined oil tended to be about the same for both or slightly higher for the former.**

To obtain an attractive edible oil, crude cottonseed oil is usually refined "dry" in America, using strong alkali which greatly reduces the bulk and gives a firm soapstock easy to handle. In Europe the so-called "wet" method employing dilute alkali is usually used. It is generally known that the "dry" method yields better refining colour especially for highly-pigmented cottonseed oil. A modified method, in which the oil is refined as by the "dry" method, and then showered with hot water to keep the soap in solution and facilitate its tapping off, has been evolved: this is called here the "wet soap" method to avoid confusion with the "wet" method of refining in which dilute lye is used. The present paper compares the "dry" with the "wet soap" method for the refining of filtered and unfiltered crude cottonseed oil, and for oil from whole seed and from dehulled and delinted seed.

The equipment used consisted of four miniature soap kettles with conical bottoms provided with stopcocks, the whole maintained in a controllable water bath. T-shaped paddle stirrers, whose speed could be varied with appropriate pulleys, were provided. The "dry" method was the official AOCS procedure Ca-9a-41 adopted with slight modifications. Neutralisation was done rapidly at room temperature, and stirring continued at 250 r.p.m. for 30 mins. The temperature was then raised to 70°C and the agitation reduced to 65 r.p.m. for 15 mins., after which the oil was settled overnight and then decanted from the firm soaptock. For the "wet soap" method, the alkali was added at 50°C, with stirring at 250 r.p.m., the temperature raised to 70°C. for 10 mins. and the mass settled for an hour. Then hot water equal to 10% of the weight of oil was sprayed on the surface, allowed to settle for two hours, and the hot-soap solution withdrawn below. Refining losses were then determined. Colour was measured on a Lovibond Tintometer using ¼" cell. The results are presented in Tables I to V.

## TABLE I.

Seed : Delinted and Dehulled Cottonseed.
Oil : Unfiltered oil, f.f.a.=1.7% oleic.
Refining : "Wet soap" Method.

| Expt. No. | Percent excess lye over theoretical. | Refining Loss. | Colour in Lovibond Units on ¼"cell. | |
|---|---|---|---|---|
| | | | Y | R |
| 1. | 0 | 4.90 | 26 | 5.8 |
| 2. | 20 | 4.70 | 26 | 5.4 |
| 3. | 40 | 4.50 | 25 | 4.3 |
| 4. | 60 | 4.30 | 25 | 3.0 |
| 5. | 80 | 4.20 | 23 | 2.5 |
| 6. | 100 | 3.70 | 21 | 2.4 |
| 7. | 160 | 4.40 | 20 | 2.0 |
| 8. | 240 | 5.70 | 20 | 1.5 |
| 9. | 380 | 6.58 | 20 | 1.4 |
| 10. | 440 | 6.58 | 20 | 1.2 |

**Conclusions from Table I.:**

Colour is steadily reduced with increasing excesses of lye, with an optimum at about 240% excess lye. The refining loss falls to a minimum of 3.7% and then rises again; this is probably due to the presence of a definite amount of suspended matter.

## TABLE II.

Seed : Delinted and Dehulled Cottonseed.
Oil : Filtered oil, f.f.a.=1.8% oleic.
Refining : "Wet soap" method.

| Expt. No. | Percent excess lye over theoretical. | Refining Loss. | Colour in Lovibond units on ¼" cell. | |
|---|---|---|---|---|
| | | | Y | R |
| 1. | 0 | 4.60 | 25 | 8.0 |
| 2. | 50 | 4.90 | 24 | 3.8 |
| 3. | 100 | 5.00 | 20 | 2.8 |
| 4. | 150 | 5.20 | 20 | 2.2 |
| 5. | 200 | 5.70 | 20 | 2.0 |
| 6. | 250 | 6.30 | 18 | 1.6 |
| 7. | 300 | 6.50 | 15 | 1.6 |
| 8. | 350 | 6.50 | 15 | 1.5 |

**Conclusions from Table II.:**

Colour is steadily reduced with increasing alkali excesses, with again an optimum at about 250% excess lye. The refining loss shows a parallel steady rise without the minimum as in Table I. Filtration of crude cottonseed oil does not influence subsequent colour after refining.

### TABLE III.

Seed : Delinted and Dehulled Cottonseed.
Oil : Unfiltered oil. f.f.a.=1.7% oleic.
Refining : 'Dry' Method.

| Expt. No. | Percent excess lye over theoretical. | Refining Loss. | Colour in Lovibond units on ¼" cell. | |
|---|---|---|---|---|
| | | | Y | R |
| 1. | 50 | 5.10 | 20 | 5.2 |
| 2. | 100 | 5.00 | 20 | 3.8 |
| 3. | 150 | 7.20 | 18 | 3.0 |
| 4. | 200 | 5.20 | 16 | 2.6 |
| 5. | 225 | 5.70 | 16 | 2.5 |
| 6. | 250 | 6.20 | 15 | 2.5 |
| 7. | 275 | 6.30 | 15 | 2.4 |
| 8. | 300 | 6.60 | 14 | 2.2 |
| 9. | 325 | 6.60 | 12 | 2.2 |
| 10. | 350 | 7.90 | 12 | 2.0 |
| 11. | 375 | 7.90 | 10 | 2.0 |

**Conclusions from Table III.:**

Colour by the "dry" method is steadily reduced to a greater degree than by the "wet soap" method. Refining losses rise steadily upto and perhaps beyond 375% excess lye (7.9% loss), whereas in the "wet soap" method it became steady at about 300% excess lye and 6.5% refining loss: this point is common to both methods for this particular oil.

### TABLE IV.

Seed : Whole seed.
Oil : Filtered oil, f.f.a.=1.3% oleic.
Refining : "Wet soap" method.

| Expt. No. | Percent excess lye over theoretical. | Refining Loss. | Colour in Lovibond units on ¼" cell. | |
|---|---|---|---|---|
| | | | Y | R |
| 1. | 150 | 3.90 | 20 | 2.0 |
| 2. | 200 | 3.80 | 18 | 1.7 |
| 3. | 250 | 4.00 | 18 | 1.6 |
| 4. | 300 | 4.60 | 17 | 1.5 |
| 5. | 350 | 4.80 | 15 | 1.4 |
| 6. | 400 | 5.10 | 14 | 1.3 |
| 7. | 450 | 5.30 | 12 | 1.2 |

## TABLE V.

Seed : Whole seed
Oil : Filtered oil, f.f.a. = 1.3% Oleic.
Refining : "Dry" method.

| Expt. No. | Per cent excess lye over theoretical. | Refining loss. | Colour in Lovibond units on ¼" cell. | |
|---|---|---|---|---|
| | | | Y | R |
| 1. | 200 | 4.40 | 22 | 1.6 |
| 2. | 250 | 4.80 | 20 | 1.5 |
| 3. | 300 | 5.30 | 15 | 1.4 |
| 4. | 350 | 5.40 | 12 | 1.3 |
| 5. | 400 | 5.60 | 10 | 1.3 |
| 6. | 450 | 5.70 | 10 | 1.2 |

**Conclusions from Table IV and Table V.:**

"Dry" refining again yields a better colour than "wet soap" refining, but the refining losses are about 0.5% higher in the former case. The refining loss levels off in both cases, at 5.7% for the "dry" method and 5.3% for the "wet soap" method. These tables are not comparable to the earlier table, since different raw oils were used.

**General Conclusions:**

Upto about 200% excess lye, the soapstock by the "dry" method is not hard. The "wet soap" refining method gives generally lower refining losses than the "dry" method, but colour is about the same or slightly higher. Thus the method as the advantages of the "dry" method, and can be used on the type of refining kettles now in use in this country.

# ADSORBENT CLAYS FOR OIL BLEACHING

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Two types of clays are used in oil bleaching: the natural Fuller's earths and the activated clays. Several characteristics of activable clays are now known by which it is possible to get a preliminery idea as to the potentiality of a clay for bleaching purposes. The process of activation varies and has to be determined for each particular clay. The mechanism of bleaching is in the majority of cases one of simple adsorption, but may be more than this in some cases. In addition to bleaching, the clay introduces certain changes in the properties of the oil, which may affect its quality. It is now possible to predict the pattern of these changes from a knowledge of the properties of the clay and thus a rational basis for the selection of the right type of adsorbent for any particular bleaching problem has been secured.

Various investigations on the activation of Indian clays tend to suggest that there is the prospect of developing bleaching clays from local materials to meet the requirements of the industry, a part of which is already being produced in the country.

Bleaching is a process for the removal of colouring matter from oils and fats. Usually all oils meant for hydrogenation are bleached to a nearly colourless shade and oils meant for other purposes are frequently, though not invariably, bleached. In the normal sequence of processing oils, bleaching is usually preceded by alkali refining which, apart from removing a part of the colouring matter, is believed to make the residual pigments more amenable to adsorption.

Fuller's earth is the most widely used adsorbent for oil bleaching. Mineralogically, Fuller's earth does not signify a sharply defined class of clay minerals, and is composed of mixture of clays at various stages of decomposition, the most important of which is montmorillonite. Thus, there is a wide divergence in the composition and properties of Fuller's earths derived from different sources. The properties which decide the suitability of an adsorbent for oil bleaching are a high degree of colour removal together with easy filtrability, low oil retention, absence of the development of odour or colour reversion during storage. Since the amount of oil lost in the spent adsorbent is a major economic factor in the choice of the clay, there is always a demand for better and more efficient adsorbents which may be used at lower dosage for the desired degree of decolourisation. Activated clays have to a constiderable extent fulfilled this demand.

## Activated Clays :

Activated clays were first developed in Germany in 1905-6. from an inactive white earth by simple acid treatment. The work has since been taken up in other countries, with surprisingly good results in some, particularly U.S.A. As a consequence of these investigations, certain identifying characteristics of the activable clays have been distinguished by which the potentially useful clays may be sorted out from the large number of inactive and non-activable clays. Some of these characteristics are described below; it should be clearly understood, however, that their significance lies in giving indications only and none of the characteristics is in itself adequate enough to determine the suitability of any particular clay with certainty.

## Characteristics of Activated Clays :

It was realised quite early that chemical composition is no guide by which the activity of a clay may be assessed. Thus it is quite common to encounter two clays of very similar chemical composition, only one of which is active in bleaching and the other is not. However, appreciable quantities of soluble silica (1) have been found to be a feature of many activated clays. It has further been claimed that on treatment with N/2 hydrochloric acid for 3 hours, promising clays should liberate 16-18% of the total $R_2O_3$ present. A high silica-alumina ratio is considered to be a good criterion, but again all clays with high silica-alumina ratio are not good adsorbents. Due to their high montmorillonite content, bentonotic clays have been widely investigated for the preparation of bleaching agents. The highly swelling Wyoming type of bentonites, however, has not been found suitable for activation(3); the sub-bentonitic types which swell only slightly and slake with water are the clays most useful for the purpose. In addition to these, some clays belonging to the glauconite, montronite or kaolin type have also been activated. But the degree of activity reached is low compared to that obtained in the sub-bentonite clays. Kaolins usually lose their water between 450°-700°C while bleaching clays do so progressively from 200° to 900°C (4). A straightline dehydration curve is said to be a characteristic of activated clays indicating the presence of gel-type bodies, as opposed to crystalline minerals (as in Kaolin) which give breaks in their dehydration curves.

## Method of Activation:

The process of activation consists usually of treatment of the clay with mineral acids, 20-35% on the weight of the clay, for 3-6 hours at an elevated temperature which may vary from 105°-130°C. Both hydrochloric and sulphuric acids have been used for this purpose. As with inadequate acid concentration there is a risk of incomplete activation (5), so with too high a dose of acid, there is the risk of over activation. Acid treatment usually removes the bases like Na, Ca, Mg, Fe, Al etc., replacing these with hydrogen. For thermal activation (6), heating the clay to temperatures as high as 535°C has been recommended. Heating the clay to 300° to 400°C causes no structural change (7), and hence the increased activity must be due to freeing the particles of adsorbed water, but at too high a temperature there is a clear risk of overheating with loss in adsorption capacity.

**Mechanism of bleaching:**

Adsorption is generally believed to be the mechanism involved in bleaching and the Freundlich adsorption equation has been shown to be applicable particularly at low colour concentrations (8, 9). With deep-coloured oils, however, deviation from the adsorption equation has been noted. Oxidation as the probable mechanism on bleaching was put forward by Wesson (10) and was disputed by Eckar (11). In some cases, oxidation has been found to transform the pigments resistant to adsorption (12). The catalytic nature of bleaching was indicated by the ability of some Fuller's earths to decompose hydrogen peroxide (27).

Although clays are primarily used for the removal of colouring matter, it is not the sole function of the adsorbent; there are a number of important side effects produced which may affect the quality of the oil. Thus traces of soap left in oil after alkali refining have been found to be removed by bleaching (13). With some clays, the residual soap is decomposed by a base exchange mechanism (14) with the liberation of the fatty acids. Peroxide values have been reduced by acid clays (15) and, in this respect, the lower the pH value of the clay, the greater the reduction in peroxide value. This initial reduction in peroxide value does not by itself improve stability; on the other hand this may lead to increased peroxide formation during storage. In cottonseed oil, bleaching with Fuller's earth was found to cause the development of substances which give positive Kries test (16). Development of off-flavour has also been caused by bleaching in some cases (17, 18). With sesame oil, the addition of which in vanaspati is statutory in India, bleaching has been found to cause serious loss of sesamolin (19)—a fact which may ultimately lower the prescribed colour reading with vanaspati in the Baudouin test, inspite of the fact that the requisite quantity of sesame oil has been added. Another interestesting effect of bleaching is the development of fresh unsaturation and conjugation in vegetable oil (20)—linoloic acid oils giving rise to triene conjugation and linolenic acid oil giving rise to tetraene conjugation. The effect of bleaching groundnut oil with natural and activated clays has been found to follow two distinct patterns (21). In one case the acid value is slightly raised, the peroxide value reduced and triene conjugation introduced in the fatty acid structure. In the other case, no such changes occur and the character of the unbleached oil is more or less maintained in the bleached oil. It has also been demonstrated that acidic clays bring about the former series of changes while the neutral clays do not and a simple knowledge of the acidity of the clay will enable a prediction of the probabe changes that the oil may undergo by bleaching (22).

## Work with Indian Clays:

Natural Fuller's earths of the type found in Surrey or Florida have not been found in India. As such, numerous investigations have been directed to the activation of Indian clays. Kulkarni and Jatkar (23) have examined a number of clays from Jodhpur, Kolhapur, Hyderabad (Sind), Katni, Murwara. The three former varieties were found to give useful adsorbents for the bleaching of groundnut or safflower oil. A number of Indian clays were also investigated by Parekh and Baidya (24) and some North India clays (6) by Sarin and Kukeraja. One Hyderabad (Dn.) earth was found, on treatment with hydrochloric acid, to give an adsorbent comparable to foreign imported clays (25). A number of bentonitic and Kaolin type of clays were studied by Sengupta and Basu (26), amongst which Karanpura Kaolin, Kashmir bentonite and Multani clay were found to be better than others.

## Conclusion:

With her large oil resources, India is a big consumer of bleaching clays. Until recently these clays were all imported from outside. At present there is one factory producing activated bleaching clays from indigenous materials. The target for the first Five-Year Plan has been set at 2500 tons per annum which is proposed to be doubled during the second. The foreign clays are costly, and sometimes fetch a pice 2—3 times that of the Indian clays, but are to some extent indispensable since the Indian products cannot yet satisfy fully all the varied demands of the oil industry. But there is reason to hope, that with further research and development, for which a good start has been made, the country will be able to meet her own requirements in the near future.

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# 'BLEACHING EARTHS' FROM HYDERABAD STATE

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**Bleaching earths, Fuller's earth and Shrirangpur clays have been studied for their bleaching efficiency and physical properties after activation. The processes for activation of same are described. From these studies it has been concluded that the activated Hyderabad earths are fairly comparable with the foreign earths used in industry. Possibility of commercial utilization of these earths has been indicated.**

Bleaching with adsorbents still remains the most effective means for the removal of colours of vegetable oils. These earths are mostly used after activation, and in a few cases raw earths are also used as filter-aids as well as colour adsorbents to a certain extent. In India the annual consumption of such earths, both raw and activated, is about four to five thousand tons; out of this, only about 1000 to 1500 tons of activated varieties are manufactured in this country, and the rest is imported mainly from Britain, America and Germany under various trade names.

Large deposits of Fuller's earths and other similar clays are reported to occur in the State of Hyderabad, Rajasthan, Madhya Pradesh, Bombay, Bengal and Andhra. Only a few of these at Bombay and Rajasthan are being worked up for commercial use; the rest remain still untapped.

Hyderabad State possesses a good quantity of Fuller's earth in a concentrated area spread over two talukas of Gulberga district namely, Korvi, Chimeidlai, Sulehpeth, Dastapur, Kodli, Kudhalli, Kiroli and Chinchli in Chincholi taluka and at Gingurti in Tandur taluka. Another clay found suitable after activation for the adsorption of colour from vegetable oils is from Srirangpur, in Shadnagar taluka, of Mahboobnagar district. A number of the deposits mentioned above have been prospected and it is reported that about 40,000 tons of Srirangpur clay and 1.5 to 2.0 lakh tons of Fuller's earth are available for commercial use.

A number of processes for activation of such earths are in vogue. The methods adapted in the Central Laboratories for Scientific and Industrial Research, Hyderabad, could be divided into three different classes.

I. Treatment of the earths with 5 normal hydrochloric acid (2).

II. Treatment with 10 per cent hydrochloric acid as practiced in industry.

III. Treatment with sulphuric acid in different concentration and proportions.

The general process of activation followed by us is briefly described below :—

(i) The raw earths were first washed to free them from impurities like sand, grit, etc.

(ii) The washed earth was next treated with acids as indicated above It was then washed to free it from acid, dried and powdered.

(iii) The dry acid treated earth was then finally heated to 350°C in an electric furnace for heat activation of same.

A good number of samples of activated earths were prepared by the process indicated above and all of them were tested on raw filtered groundnut oil and also on alkali refined groundnut oil. It was found that most of the samples so prepared compared very well with the foreign samples used by the vegetable oil refining industry in this country.

The colour adsorption is mostly a physical phenomenon and appears to depend on many of the physical properties of the adsorbent such as pH, bulk density and particle size, etc. It has been pointed out that bleaching activity is to some extent, directly proportional to the acidity of the earth sample. The colour adsorption property seems to be of a selective nature and one sample effective for a particular oil may not be so for another. An attempt was therefore, made to correlate the physical properties with bleaching efficiency of the sample activated in the Central Laboratory as well as of the foreign samples.

From these studies it was found that by suitable changes in the method of activation, a sample having the maximum possible colour adsorption could be prepared.

Considering the nature and the extent of the deposits of fullers' earth in Hyderabad, and the high degree of bleaching efficiency shown by them after activation, their Commercial exploitation has distinct possibilities. Imported varieties of such activated earths, are sold in India at about Rs. 800/- per ton, whereas the price of the raw earth works out to only Rs. 40/- to Rs. 50/- per ton. It is thus evident that a handsome margin of profit exists for the manufacture of activated bleaching earths.

From the encouraging results obtained, a scheme for the commercial utilization of the existing deposits of bleaching earths of Hyderabad State, is under active contemplation in the Central Laboratories for Scientific and Industrial Research, Hyderabad (Dn.) .

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# DEODOURAISATION OF NEEM OIL

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**Owing to its disagreeable and persistent odour neem oil does not find much commercial use and its vast potential resources remain mostly unexploited even to this day. The neem oil industry can be developed if the oil can be deodourised by a cheap and easy method which may be adaptable on a small scale. The following method has been worked out for the removal of the odour of the oil.**

**The oil is neutralised with an alkali solution to remove the free fatty acids present in the usual way. The soap formed is allowed to settle and the clear oil decanted off. The neutralised decanted oil is then successively boiled with its own volume of 1.5% solution of citric acid, 2.5% solution of sodium hydrosulphite and 2.0% solution of lead acetate. The oil is then washed 3 or 4 times with hot water dried and finally bleached with 1.5% Tonsil A. C.**

Neem (Margosa), **Melia azadirachta** belonging to the natural order Meliaceæ, is a very well-known tree of India. It grows all over the country thriving best in drier areas where rainfall varies from 20 to 40 inches. The tree is well suited for afforestation on account of its peculiar habitat (1). Neem tree is of considerable economic importance as every part of it, from the bark to the fruit, can be put to some use or the other, all of these i.e. bark, leaves. flowers, fruit, gum and sap have been attributed medicinal properties and recommended in Ayurvedic and Unnani systems of medicine.

Uttar Pradesh alone is estimated to possess about 30 lakhs of neem trees capable of producing about 40 lakhs maunds of seed per year (2) and if most of the neem fruit is collected and processed into seed and crushed, it will produce about 15 lakh maunds of neem oil.

During the latter part of the summer season and early part of the monsoons each tree produces on an average 4 maunds of ripe fruit. The fruit produces about 10-15% of dry kernel which contains about 45-50% of neem oil which has a bitter taste and disagreeable odour. As the oil is non-edible and finds little industrial use, vast potential resources of the neem fruit remain mostly unexploited even to this day. Only a very small percentage of the total produce of the fruit is collected and crushed, the oil being used since times immemorial by villagers for burning, lubricating and medicinal purposes.

If neem oil industry is to be developed it is necessary to remove the odour of the oil by a cheap and easy method adaptable on a small scale. Wellknown scientific methods are available for deodourising oils but they are too elaborate and complicated to be taken up on a small scale or by cottage workers. Moreover deodourising by superheated steam alone has not been found to be successful.

Work on neem oil so far carried out has been mostly directed towards its chemical and physical characteristics (4, 5, 7, 10, 11 & 12). Warden (3) in 1888 first found that the odour in neem oil was due to the presence of a sulphur compound and removed it by extraction with alcohol. Watson, Chatterjee and Mukherjee (6) attributed the characteristic odour to the presence of certain volatile sulphur compounds and recommanded its removal by steam distillation. Siddiqui (13) found that the oil can be deodourised by successive extractions with alcohol while Ghosh and Das (18) further improved the method by passing the alcohol extracted oil through a column packed with the layers of activated alumina and a potential absorbent "Tonsil". These methods, however, do not appear to be simple and adaptable on small scale.

In recent years simpler methods have been suggested. Carleton (14) suggests blowing of air in oil in presence of varying proportions of (20-60%) by weight water at temperatures 110-225°F for 10 to 15 minutes. The malodorous and unpleasant tasting compounds present in oils and fats together with the relatively highly unsaturated glycerides are said to get saturated by a preferential or selective hydroxylation thus resulting in the elimination of undesirable taste and odour.

Arniell (15) reports that deodorisation of oils can be further assisted by the addition of various materials like $H_3PO_4$, Citric acid, Sodium Hypochlorite etc., Shojirokahida (16) found that oils can be deodourised by heating with manganic oxide and acid clay at 90°C. Lyubachanksya (17) found that 0.02 to 1.5% of Citric acid on the weight of oil is most effective in the deodurisation of vegetable oils.

In recent years attention (9) has been drawn to the powerful bleaching action of sodium hypochlorite. Of reducing bleaching agents mention may also be made of sodium hydrosulphite.

**Experimental :**

A pure sample of freshly pressed neem oil was obtained which had the following characteristics :—

| | |
|---|---|
| Colour (in 1" cell, Lovibond Scale) | Y – 40<br>R – 6 |
| Acid value | 8.4 |
| Specific gravity at 30°/30°C. | 0.9189 |
| Saponofication value | 193.6 |
| Iodine value | 75.8 |
| Unsaponifiable matter. | 2.0% |
| Hehner value | 88.7 |

The oil was neutralised in the usual way with caustic soda. The soap formed was allowed to settle and the clear oil decanted off.

The neutralised neem oil was then taken in an enamelled iron basin with an equal volume of water and boiled separately with different quantities of alum, citric acid, sodium hydrosulphite and lead acetate and for varying lengths of time. After allowing the mixture to stand and drawing off the aqueous portion, the oil was washed several times with equal volumes of hot water.

It was then dried and bleached with 1.5% Tonsil A. C. The results obtained are given in Table No. 1.

**TABLE No. 1.**

| Sl. No. of Exp. | Chemical used & its % on the wt. of oil. | | Time of treatment. | Remarks. |
|---|---|---|---|---|
| 1. | 2. | | 3. | 4. |
| 1. | Alum | 0.5 | 30 minutes | No change in colour or odour. |
| 2. | ,, | 1.0 | ,, | — do — |
| 3. | ,, | 1.5 | ,, | Very slight change in appearance. |
| 4. | ,, | 2.0 | ,, | No further improvement. |
| 5. | Citric acid | 0.5 | ,, | No change. |
| 6. | ,, ,, | 1.0 | ,, | No appreciable change. |
| 7. | ,, ,, | 1.5 | ,, | Slight change in odour. |
| 8. | ,, ,, | 2.0 | ,, | No further improvement. |
| 9. | Sodium hydrosulphite | 0.5 | 90 minutes | No change. |
| 10. | ,, ,, | 1.0 | ,, | — do — |
| 11. | ,, ,, | 1.5 | ,, | No change in odour but slight improvement in odour. |
| 12. | ,, ,, | 2.0 | ,, | Slight improvement in odour and colour. |
| 13. | ,, ,, | 2.5 | ,, | Further improvement in odour and colour. |
| 14. | ,, ,, | 3.0 | ,, | No further change. |
| 15. | Lead Acetate | 0.5 | 40 minutes | No change in odour. |
| 16. | ,, ,, | 1.0 | ,, | — do — |
| 17. | ,, ,, | 1.5 | ,, | Slight change in odour. |
| 18. | ,, ,, | 2.0 | ,, | Improvement in odour. |
| 19. | ,, ,, | 2.5 | ,, | No further improvement. |

Above results show that by treatment of the oil with 1.5% of alum, 1.5% of citric acid, 2.5% of sodium hydrosulphite and 2.0% of lead acetate there is a reduction of its disagreeable odour. Further experiments were carried out to study the combined effects of the above chemicals.

500 gms. of the neutralised neem oil were taken with equal volume of water and boiled using one chemical at a time. The oil was separated from the aqueous solution after standing and again boiled with equal volume of fresh water and using another chemical and so on. After the last treatment the oil was washed several times with the hot water, dried and finally bleached with 1.5% Tonsil A. C. The results obtained are given in Table No. 2.

TABLE No. 2.

| No. of Expts. | Chemical used & its % on the wt. of oil. | | Time of treatment. | Remarks. |
|---|---|---|---|---|
| 1. | 2. | | 3. | 4. |
| 1. | Alum<br>Citric acid | 1.5<br>1.5 | 30 minutes<br>30 minutes | Very slight change in odour and colour. |
| 2. | Alum<br>Lead acetate | 1.5<br>2.0 | 30 minutes<br>40 minutes | Slight change in odour and colour. |
| 3. | Alum<br>Sodium hydrosulphite. | 1.5<br>2.5 | 30 minutes<br>70 minutes | Slight change in odour & substantial improvement in colour. |
| 4. | Lead acetate<br>Sodium hydrosulphite | 2.0<br>2.5 | 40 minutes<br>70 minutes | Substantial improvement in odour and colour. |
| 5. | Alum<br>Sodium hydrosulphite<br>Lead acetate | 1.5<br>2.5<br>2.0 | 30 minutes<br>70 minutes<br>40 minutes | No further improvement over Experiment No. 4. |
| 6. | Citric acid.<br>Sodium hydrosulphite<br>Lead acetate | 1.5<br>2.5<br>2.0 | 30 minutes<br>70 minutes<br>40 minutes | Almost total disappearance of disagreeable odour and substantial change in colour. |

**Conclusion :**

The disagreeable odour of neem oil can be practically removed by the following process :—

1. The oil is neutralised in the usual way with alkali to remove the free fatty acids present. The soap formed is allowed to settle and clear oil decanted off.
2. The neutralised oil is successively boiled with equal volumes of water containing 1.5% of citric acid, 2.5% of sodium hydrosulphite and 2.0%

of lead acetate. Each time the aqueous solution is removed by settling. Finally the oil is washed several times with hot water.

3. The resulting oil is dried and bleached with 1.5% Tonsil A. C.

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# REFINING OF VEGETABLE OILS

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As the technology of oils, fats and allied products advances into that of more specialized, useful and valuable materials, each step in the production of the basic raw material must be more selective and carefully controlled. Quality and flexibility now become equal partners to economy in production, and continous centrifugal refining becomes essential.

To appreciate the overall complexity of the problem, it will be necessary to examine the component steps of refining. The four basic steps of refining will be discussed in turn, integrating into each step the implications of profit through by-products.

Refining of a crude oil may be divided into four fundamental and separate considerations.

(1) Treatment and ultimate removal of phosphatides.
(2) Neutralization and removal of free fatty acids.
(3) Removal of colour bodies.
(4) Removal of traces of soap and moisture by washing and drying.

These four factors are sufficiently independent that production process designs may encompass any or all of them, either simultaneously for design simplicity or separately for economy in operation.

Coupled with proper selective treatment of the oil, however, is the equally important problem of producing a profitable by-product. Edible and pharmaceutical lecithin, industrial glazing compounds, laundry soap, black grease, free fatty acids and distilled acids all form important outlets for these by-products, but each requires a unique selection of refining process equipment to produce the material required.

## Phosphatides:

Gums represent the natural phosphatidic materials contained in crude vegetable oil. Some oils such as palm or coconut have so little of this contaminant that conditioning and removal need not be considered. On the other hand, cottonseed and soya contain from 1% to 2% gums which must be removed to produce a refined edible or technical break-free oil.

To a large extent the gums are in solution in dry crude oils, but may be precipitated as a non-oil soluble sludge by hydrating with water. The precipitate is a geletinous mass wherein oil is dissolved in the gums. This mass is easily discharged from a continuous centrifuge.

| Treat | Gums in Sludge (Dry) | Gums Removed | Non-Break Oil | Purpose |
|---|---|---|---|---|
| 3-4% | 70-75% | 60-80% | No | Commercial lecithin. |
| 3% | 60-65% | 80% | No | Gums, or cleaner subsequent soapstock. |
| 5% | 60% | 90% | Fair | Technical oil. |
| 10% | 40% | 90% | Fair | Not practical, emulsions. |
| 3% | 60% | 99% | Good | Technological oil (Double de-gummed) |

Table shows that a low water treat will precipitate for centrifugal removal only about 60% of the gums, but that these gums are of high quality. Water added in quantities of 3 to 5% will more nearly degum the oil for technical purposes, but occasionally such a degumming is carried out to eliminate the gums from the subsequent free fatty acid soapstock in order to obtain a cleaner soapstock to be made into laundry soaps. Too much water will promote emulsions which cause loss of oil.

The finest grades of drying oils are obtained by double degumming with two treats of 3 to 5% water each and any well designed, two stage centrifugal plant should allow for this operation if technical oils are to be sold.

In many continuous refining installations the gums are not re-moved separately, but are combined with the soap produced by neutralising the free fatty acids. In this case the water associated with the neutralizing chemicals is sufficient to thoroughly degum the oil. If the soapstock is to be acidulated for production of free fatty acids, the presence of gums does not matter since most of the gums will be water soluble and separate with the mineral acid

The Sharples Low Loss Process recognizes the solubility of oil in separated gums and adds an aliphatic acid such as citric or tartaric acid to reduce this solubility. When combined with a subsequent caustic treat, the gums are removed simultaneously with neutralized free fatty acid with minimum loss of oil.

Combined soapstocks, with or without citric acid, can be strikingly upgraded by subsequent caustic treatment, salt washing and continuous acidulation. This process is known as the Sharples Foots Process and yields a purified, fully saponified soap of 55% TFA or a high grade free fatty acid wherein the acid number approaches the saponification number within 5 points.

**To summarize:**

(1) The best technical oil is made by double degumming with 3 to 5% water.

(2) The most economical refining for fully refined technical oils or edible oils is obtained by conditioning the gums with an aliphatic acid prior to neutralizing in the Sharples Low Loss Process.

(3) The best lecithin is obtained by degumming with 3/4 to 1% water.

(4) Good soaps are made from soapstock from oil refined after the gums have been removed.

(5) The best soap and fatty acid are derived from the Sharpless Foots Process.

**Fatty Acids:**

Free fatty acids exist to some extent in all natural oils. These must be neutralised into a soap and removed in order to produce an edible oil or fully refined technical oil. Gravity settling in a kettle or any grade of centrifuge will adequately remove this soap, but type of reagent, quantity of reagent and type of centrifuge materially affect the degradation of oil into soap, or the loss of neutral oil into the separated soapstock. The following systems have been offered:

(1) Treatment with caustic in sufficient quantity to neutralize free fatty acids and remove color at the same time. Excess caustic saponifies neutral oil and promotes loss. This is the least expensive continuous system to install and the least profitable.

(2) Treatment with only enough caustic to neutralize the free fatty acids leaving color removal for a separate step. This is the principle of the Sharples Low Loss Process and shows an excellent gain in neutral oil recovered.

(3) Treatment with soda ash, tri-sodium phosphate or other reagents which will not saponify neutral oils while neutralizing free fatty acids. Excellent results are obtainable, but separate reagent supplies must be maintained since caustic is still needed to reduce color in a separate step.

If soapstock for laundry soap is desired, whether contaminated by gums or not, soda ash acts as a soap grain inhibitor. Caustic soapstock are preferred for this purpose.

It is during this step that most of the avoidable losses of refining take place. A minimum dosage of saponifying caustic and high squeezing forces available in modern centrifuges hold the key to economical refining. The soapstock produced, whether it contains also the precipitated gums or not, is compressible as is a sponge, squeezing out of its matrix more neutral oils as the magnitude of the force is increased. Since hydraulic forces have no effect, the easily cleaned open tubular centrifuge which is designed to give the highest possible centrifugal force is selected as a component of the most economical Low Loss Process.

As discussed above, the soapstock from neutralizing the free fatty acids becomes basically a soap contaminated more or less by gums, unsaponified neutral oil, excess reagent and color. Separate removal of gums prior to refining or purification of the crude oil will give an improved product for soap making. Sulphuric acid can be used to free the fatty acid from any of the soapstocks, the grade and value of the product being dependent on the purity of the soapstock being acidulated. As much as 50% premimum has been established for fatty acids acidulated from purified soapstock from the Sharples Foots Process.

## Color :

Color must be removed by the use of sodium hydroxide. Some oils such as coconut and groundnut do not need much treatment to meet required color specifications, while some oils like soya give up most of the color while being deodorized. However, to some extent all edible oils must be decolorised with caustic and many oils such as cottonseed require heavy treatment.

The caustic for this decolorizing step may be added as an excess to that used for neutralizing the free fatty acids if the installation does not provide equipment for a separate step. However, the catalytic nature of neutral oil saponification must be recognized. If soap is present from any source (such as neutralizing the free fatty acids), the intimate contact between entrained oil and excess caustic of the water phase of the soap quickly promotes destruction of neutral oil triglycerides by saponification.

If no soap is present, this action is very slow and large doses of decolorizing caustic may be added without serious refining losses.

The most efficient decolorizing is carried out as a separate step on oil previously degummed, neutralized and separated into a dark neutral oil. This step is called rerefining and because heavy doses of strong caustic can be used without damaging the economy of the operation, even the darkest cotton oils can be decolorized to equal or better the oil produced by the best kettle refining. Such a step is supplied with all of the best and most modern installations including those of The Sharples Low Loss Process, and it becomes a necessity if a non-saponifying reagent such as soda ash is used as the neutralizing chemical.

Since very little soapstock is produced, and since by nature this soap is very hard, it is usually flushed out of the rerefining centrifuges with a continuous stream of water, thereby promoting operational stability and reducing the necessity for cleaning. This dilute soapy effluent is usually regarded as a waste, containing too few valuable constituents to be worth recovering. Excess alkalinity inherent in the fact that caustic at this stage saponifies very little oil requires too much neutralizing sulphuric acid to make acidulation attractive.

## Water Wash and Vaccum Dry :

Any system, whether it be kettles or centrifugal, should embody these steps. They are inexpensive to operate and perform the task of eliminating the last traces of soap and moisture. Oil which has been properly refined and decolorized will run from 200 to 800 parts per million of soap and about 0.3% moisture. Single water wash can reduce this figure to 50 PPM soap, or less, double water wash can produce oil down to 5 PPM soap, and vacuum drying will give a clean brilliant oil of 0.03% moisture.

The water from the water wash is considered waste since, again, it contains too little material to recover.

## Conclusion :

The details of process equipment and basic technical discussions of gum treatment, triglyceride saponification, centrifugal squeezing, rerefining for color and by-product manufacture have been reported in the literature many times. It is not the purpose of this paper to reiterate this information, but rather to show how important it is to select equipment which can meet any quality specification predicted for it, do this in manner which best balances operating costs against available capital, and to produce at the same time a by-product which is of most value.

The least costly combination for continuous refining would utilize single combined caustic degumming, neutralizing and decolourizing step with single water wash, vacuum drying, and kettle soapstock acidulation or sale of the combined soap for blending into low grade soaps.

A more complicated plant would combine the ability to single or double degum for technical oil production with the ability to gum condition caustic neutralize and separately decolourize for edible oil product in the same plant. Double water wash saves bleaching earth, reduces hydrogenation catalyst poisoning and reduces winterizing press pressures. Such a plant would lead easily into any outlet for by-products.

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# NUTRITION

November 1952 that Vanaspati should be fortified with synthetic vitamin A
order to increase its nutritive value. Prior to this, namely, in April 1951,
Vegetable Oil Products Controller for India had specified that any manu-
cturer who claimed that his product was vitaminised should declare from
ay 1, 1951, onwards the names of the vitamins (A and/or D) on the labels.
urthermore, he specified that no manufacturer could claim his product as
ntaining the specified vitamins unless the quantity added was not less than
00 I.U./oz of vitamin A and 50 I.U./oz of vitamin D. Effectively, according
to this specification, the incorporation of vitamins was optional and not com-
lsory, but on May 11, 1953, he announced that the fortification of Vanaspati
th synthetic vitamin A would be compulsory from October 1, 1953, the
itial level of fortification being 300 I.U./oz. More recently, i.e. with effect
rom May 1, 1955, the level of enrichment has been increased so that the
itamin A content of Vanaspati at the time of manufacture is now 700 I.U./oz.
7).

The position at present, therefore, is that the incorporation of synthetic vitamin A in Vanaspati is compulsory by law but the addition of synthetic vitamin D is optional.

### orms and Properties of vitamin A.

Vitamin A (Axerophtol) is $C_{20}$ alcohol with a trimethyl cyclohexane ring and a $C_{11}$ side-chain, and it contains five conjugated double bonds. Its chemical formula is $C_{20}H_{29}OH$.

The vitamin A which occurs in nature is predominantly in the ester form rather than as a free alcohol. Synthetic vitamin A is available both in the form of free alcohol as well as esters. The latter are much more stable than the former. The esters normally offered are the acetate and palmitate, the principal manufacturers of these products being Messrs. F. Hoffmann-La Roche & Co., Inc., Messrs. Distillation Production Industries, Inc., Messrs. Chas. Pfizer & Co., Inc., and Messrs. Merck & Co., Inc.

In 1934, the Permanent Commission on Biological Standardisation of the Health Organization of the League of Nations defined the International Unit (I.U.) of vitamin A as the biological activity of 0.6 mcg of beta-carotene (8). It was recognised, however, that beta-carotene was not an ideal standard of reference for determining vitamin A, but no satisfactory preparation of vitamin A was available until about 1947. During the intervening period, various esters of vitamin A had been prepared and, of these, the acetate appeared to be the most suitable for adoption as a standard in place of beta-carotene. In 1950, the Expert Committee on Biological Standardisation of the World Health Organisation adopted crystalline vitamin A acetate as the international standard for vitamin A. Furthermore, it defined the International Unit as the activity of 0.344 mcg of the standard preparation of crystalline vitamin A acetate which is equivalent to 0.3 mcg of vitamin A alcohol. The results of the large scale biological tests carried out on rats for the Medical Research Council of Great Britain and for the United States Pharmacopoeia Commission have shown that this definition of the International Unit for vitamin A maintains continuity with the unit defined as 0.6 mcg of the international standard preparation of beta-carotene which was in use since 1934.

Effectively, the biological activity of synthetic vitamin A esters is exactly the same as that of the naturally occurring material and, furthermore, the efficiacy of the synthetic vitamin A preparations has been acknowledged and accepted by the World Health Organization.

**Methods of Estimation.**

The methods available for estimating the potency of vitamin A are based on :

(a) rat-curative bio-assay,

(b) absorbency in the ultra-violet region,

(c) absorbency of colours produced by chemical reaction.

The rat-curative bio-assay was the official method for the determination of vitamin A for some considerable time. The method is time-consuming and is subject to considerable experimental errors and, consequently, it is impractical for routine control purposes.

Estimating the potency of vitamin A by measuring the absorbency at the point of maximum absorption in the ultra-violet region is currently the most authentic method and it is also the one officially recommended by the Expert Committee on Biological Standardization of the World Health Organization (6, 8). This body has accepted the E(1%; 1cm) value at 325 mu of vitamin A acetate in iso-propanolic solution as 1525, corresponding to a molecular extinction coefficient of 50,000. Since 0.344 mcg of vitamin A has been adopted as the value for the International Unit, and since the E (1%; 1cm) value at 325 mu has been adopted as 1525, it follows that the factor for converting the results of spectrophotometric determinations into International Units of biological activity must be 1900. Although this is the most accurate method for assaying vitamin A potencies, it involves the use of an instrument which is very expensive and, furthermore, it cannot be used directly for estimating the vitamin A content of Vanaspati since the minor constituents of sesame oil which give rise to the Baudouin colour reaction have a very strong absorption at approximately 290 mu and thus grossly distort the vitamin A curve. In order to determine the true vitamin A content of Vanaspati, it is necessary to subject the unsaponifiable matter to a rather elaborate and cumbersome chromatographic procedure prior to performing the assay by u.v. absorption. Effectively, the prohibitive cost of the instrument as well as the cumbersome nature of the chromatographic procedure render this method impractical for routine control purposes.

Of the chemical methods, the most widely used is the Carr-Price reaction(2) in which a blue colour is formed when vitamin A is treated with antimony trichloride in chloroformic solution. The use of glycerol dischlorhydrin as a reagent for the colorimetric estimation of vitamin A was proposed by Sobel and Werbin (5) in 1947 and, more recently i.e. in 1953, Flesch (3) has suggested the use of perchloric acid in amyl acetate solution. The former reaction leads to the development of a pink colour whereas the latter is based on the formation of a purple-red colour. The Sobel method based on the use of glycerol dichlorhydrin appears to be attractive in view of the permanence of the colour, its non-sensitivity to moisture, and the non-corrosive nature of the reagent, but a major disadvantage is the low activity of the reagent which is about 25% as sensitive as chloroformic antimony trichloride. The method descrbied by Flesch is less attractive than the Sobel reaction or the Carr-Price reaction inasmuch as it is less sensitive than the glycerol dichlorhydrin method and the colour is not appreciably more stable than that obtained with antimony trichloride. Effectively, the only chemical method which appears to have stood the test of time is the one based on the Carr-Price reaction. This method has several drawbacks, such as the corrosive nature of the antimony trichloride reagent and the extremely fugitive nature of the blue coloured complex formed. Various modifications of this method have, therefore, been made from time to time by different investigators as it is perhaps the easiest chemical method of computing vitamin A potencies. The concentration of vitamin A is closely related to the depth of the blue colour formed and the latter is estimated colorimetrically or absorptiometrically at 620 mu where the antimony trichloride reaction product exhibits an absorption maximum.

In view of the numerous difficulties set forth above in respect of each one of the available methods, a particular form of the Carr-Price method was evolved by one of the authors (G.S.H.) for estimating the vitamin A content of Vanaspati. Briefy, the method is as follows.

An accurately weighed sample is saponified in the presence of hydroquinone and the unsaponifiable matter is extracted with diethyl ether. The ethereal extract is evaporated to near-dryness and the vitamin A in the unsaponifiable matter is subjected to chromatographic purification. A single column of Merck's alumina, activated according to Brockmann's specifications, is employed for this purpose and a 15 : 85 mixture of diethyl ether and light petroleum ether is used as the eluting agent(1). The intensity of the blue colour developed by the interaction of vitamin A and antimony trichloride in chloroformic solution is measured with a Unicam G. P. Photoelectric Colorimeter (Model SP. 300) fitted with a filter with spectral transmission at 620 mu. The vitamin A potency of the sample is computed from a calibration curve based on an International Standard Preparation of vitamin A issued by the World Health Organization. The size of the sample taken for the test as well as the volumes of the chloroformic solutions of vitamin A and antimony trichloride are adjusted so that the optical density is of the order of 0.25.

**Stability of vitamin A in Vanaspati during its manufacture and storage.**

It is rather unfortunate that although the incorporation of synthetic vitamin A in Vanaspati was started about two years ago and a tentative method for the estimation of vitamin A in Vanaspati by the Carr-Price technique was made available at about the same time, data pertaining to the losses in potency of vitamin A during the manufacture and storage of Vanaspati are not available from the different manufacturers of whom there are about 40 in number. The views expressed below are, therefore, based on the experience of The Hindustan Vanaspati Manufacturing Company's factories.

In the initial stages, i.e. until about the end of 1953, the losses in potency of vitamin A during the manufacturing process were quite often as high as 15%. As a result of instituting various controls at different stages during the manufacturing process, it has now been possible to reduce the manufacturing loss to less than 5%.

The loss in potency of vitamin A during the storage of Vanaspati depends upon a variety of factors of which temperature and length of storage are perhaps the most important. In the initial experiments conducted prior to 1953, it was found that storage losses during a four months' period at temperatures ranging from 30-35°C were of the order of 30 to 35%. Storage tests conducted during the last two years as well as assays on bazaar samples of Vanaspati have shown that storage losses at the end of six months do not exceed 25%. At lower temperatures, such as 20°C, the storage losses are extremely small being of the order of 5 to 10%.

The stability of vitamin A in ghee and Vanaspati at approximate levels of 650 I.U./oz has been examined(4) during some typical cooking experiments based on deep frying, shallow frying and simmering. In general, the losses in potency of vitamin A in ghee or Vanaspati are the greatest in the case of shallow frying (220°C), considerably less in the case of deep frying (200°C), and minimum in the case of cooking by simmering (100°C). In the case of deep frying and shallow frying, the losses in vitamin A potency are considerably higher in the case of ghee than in vitaminized Vanaspati. The vitamin A content of articles fried in vitaminised Vanaspati is much higher than that of those fried in ghee.

**Nutritive value of vitaminized Vanaspati.**

Vitamin A is essential for healthy tissues and for general growth promotion. It is important factor in improving general resistance to infections and certain diseases, and lack of vitamin A can lead to deficiency disorders. This, in fact, was one of the main arguments advanced against the encouragement of the Vanaspati industry and is no longer valid since the product is vitaminised to a sufficient level. According to the Nutrition Research Laboratories, Coonoor, the vitamin A activity of genuine cow ghee is about 20 to 25 I.U. per gram while that of buffalo ghee is 8 to 10 I.U. per gram. When the incorporation of synthetic vitamin A in Vanaspati was made compuslory in 1953, the nutritive value of the product (ca. 10.6 I.U./g) was equal to that of the best buflalo ghee and, at present (ca. 24.7 I.U./g), it is equivalent to that of the best cow ghee.

In 1947, the Government of India prescribed a maximum limit for the melting point of Vanaspati which ensured that the hydrogenated vegetable oil product was as nutritive as ghee from the points of view of digestibility, absorption and assimilation. By enforcing the incorporation of synthetic vitamin A, the Government have further enhanced the nutritive value of Vanaspati inasmuch as this material, which is vital for growth promotion, is now being added in a quantity equivalent to that found in the best milk ghee.

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# MONOGLYCERIDES IN FOOD PRODUCTS

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**Monoglycedides are finding increasing use in foreign countries, in food products such as breads and biscuits. The emulsifying property of monoglycerides enables incorporation of more sugar and moisture in the dough and beating in more air thereby giving a higher volume index. They also confer the property of resistance to variable conditions of baking and handling besides improving the texture of the product.**

Monoglycerides are surface active agents of the nonionic type. They possess good surface activity due to the presence of both lipophylic and hydrophylic groups in the same molecule. These are not present to any appreciable extent in natural fats but during hydrolysis of fats, mono and diglycerides are formed as intermidiates. During digestion also the triglycerides are converted gradually to diglycerides, monoglycerides and glycerol, with fatty acid liberated at each stage.

Though monoglycerides are not present in nature, they can be prepared easily by reacting the triglyceride or fatty acid with excess glycerol with or without a catalyst. The product obtained by such methods will be a mixture of mono-di-and triglycerides. The surface activity of such a product depends mainly on the quantity of monoglycerides present in the product and it has been found that monoglycerides are one hundred times more active than diglycerides (1). As such the technical product, which is normally low in monoglyceride content — about 50% — requires some purification by removing the less active di-and triglycerides from the product. The most modern method of effecting this concentration is the molecular distillation. By this process products containing 90 to 95% of monoglycerides have been obtained.

In foreign countries monoglyceriedes, both technical and purified products, are manufactured in large quantities starting from various oils or pure fatty acids. This industry has not yet come up in India although there is much scope. The technique of using this product in food is rather new to us while it has been made use of in foreign countries for the last 15 years or more in the preparation of various food products. In all these applications, the surface active property of monoglyceride is used in producing improved products.

Although monoglycerides can be used in the manufacture of various food products, they are used mainly in the bakery, where shortenings are used. In foreign countries several kinds of shortenings are manufactured while in India hydrogenated groundnut oil is the main source of bakery shortening. A shortening containing added monoglycerides is called super glycerinated shortening. The monoglyceride acts as an emulsifying agent and its function is to distribute homogeneously the fat throughout the product in fine particles.

The ability of a shortening to cream or incorporate air is an important factor if it is used for making cakes. (2). The presence of the emulsifier enables incorporation of more air in the dough than is normally possible. It also enables the baker to use a higher ratio of sugar and water to flour without causing separation or curdling of the butter. Thus a sweeter cake, having a greater volume that the one made with ordinary shortening is produced. Biscuits and such products made with such modified shortenings were found to keep well for a longer period than those made from ordinary shortening.

In the manufacture of Ice cream (3) the addition of monoglyceride gives a fine texture and produces the desired overrun more quickly.

Oleomargarine is another food product in which the use of interface modifiers is of great importance (3). It is a water-in-oil emulsion containing about 80% oil, 15% water in the form of milk and small quantities of other ingredients. On standing it shows some leakage of milk or some separation owing to the breaking up of the emulation. This tendency is prevented by using monoglycerides or esters of polyglycerols as emulsifiers which keep the emulsion firm. Monostearin sulphoacetate is used as an anti-spattering agent in such products.

A recent discovery in the food field is the global edible spread (4). This may be spread on bread or crackers at low temperatures and it will not melt or separate at higher temperatures due to the high platic range of the product. Such a product contains vegetable oil, distilled glyceryl monostearate (about 17%) and other ingredients. The consistency of this product depends on the temperature at which it is tempered (5).

Very recent products are the acetoglycerides (6, 7) which are derived from the mono and diglycerides by acetylation using acetic anhydride. These products have also got a very high plastic range. They are more greasy and they can be stretched several hundred per cent before breaking. The amount of acetic anhydride and the quality of monoglyceride influence the properties of the final product. Feeding and other physiological tests on these products are in progress in foreign countries.

As regards the nutritive properties of monoglycerides it has been found that there is not much difference between the mono—di—and triglycerides (8) except for their calorific efficiencies (9). This is due to the fact that the calorific efficiency of the mono—di—, and triglycerides of the different fatty acids is governed by their relative absortive power and digestibility, which in turn is governed by the nature of the fatty acid present. Thus the utilization values for monostearine and tristearine are the same, 20 and 20, while for trilaurin, it is 70, which is much higher compared to tristearin.

Emulsifying agents like monoglycerides are being used by a few biscuit factories in India. It is hoped that in due course other factories also will make use of such latest technique in improving their products.

We wish to express our thanks to the Tata Oil Mills Co. Ltd., for permitting us to present this paper at this Symposium.

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# NATURAL ANTIOXIDANTS FOR EDIBLE FATS

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**Many substances isolated from natural sources have been shown to be good antioxidants for oils and fats. Notable amongst these are nor-dihydroguaiaretic acid, dihydroquercetin, tocopherols and kamala dye. Recent work on various spices proved that red chilli, cinnamon leaf, turmeric, cloves, nutmeg fruit, pepper, betel leaf and dry ginger have good antioxygenic properties. Isolation of the active ingredients of some of these spices showed that hydroxy chavicol from betel leaf is a powerful antioxidant, comparing favourably with any of the well-known antioxidant.**

The on-set of rancidity in fats makes them unpalatable and destroys to a considerable extent the nutritive compounds like the carotenes, fat soluble vitamins (1, 2) and the essential fatty acids, present therein. It has been shown that the destruction of these compounds begins even before the rancidity can be detected organoleptically. Oxidation of an insignificant proportion of the total fat (0.1%) may be enough to make it organoleptically rancid (3). Hence the use of antioxidants is important for preserving the palatability and the nutritive value of fats.

A number of substances isolated from natural sources have been shown to possess antioxidant properties. Some of these can be produced in large amounts at reasonably low prices for commercial use.

Nor-di-hydro-guaiaretic acid (N. D. G. A.) was first reported by Lundberg *et al* (4), to possess excellent antioxidant properties. It is obtained by the extraction of the creosote bush (Larrea divaricata) and is being used commercially for the preservation of animal and vegetable fats. Chemically it is '4, 4, — (2, 3-dimethyltetramethylene) — dipyrocatechol', and as a white crystalline solid (m.p. 184° — 185°C), sparingly soluble in fats. It has been shown that N. D. G. A. is also a good stabilizer for carotene and vitamin A of the oils (5).

Nor-conidendron, obtained from the sulfite waste liquor of western hemlock, has been found to be an effective antioxidant for certain vegetable oils by Fischer *et al* (6), and for fats, oils and candies by Mack and Bickford (7).

Kurth and Chan (8) reported that dihydro-quercetin possesses an antioxidant activity of the same order as some of the better known phenolic antioxidants. As it can be extracted with hot water from the bark of the douglas fir, it can be produced on a large scale cheaply. It imparts no colour, odour or taste to fats and is non-toxic.

Olcott and Mattill (9) found that vitamin E was also a good stabilizer for fats. Later on, it was established that Beta, gamma and delta tocopherols are effective natural antioxidants (10) for animal fats, but that they have very little activity for refined vegetable fats (11). The antioxidant activity of the wheat germ oil is also attributed to the high percentage of tocopherols present in it.

A few antioxidants have been isolated from the non-saponifiable fraction of some of the vegetable oils. Thus, sesamol from sesame oil (12, 13) and gossypol from cottonseed oil (14, 15) have been proved effectively for the preservation of lard. Gossypol has only slight protective influence on refined cottonseed oil (16), but has been shown to be capable of protecting carotenes from destruction (17). The antioxidant activity of crude lecithin (18) is more pronounced towards vegetable oils (19). The main drawback with these compounds is that there isolation is tedious and that they are quite selective in their activity.

Kamala dye, the red colouring matter obtained from the seeds of Mallotus phillipinensis has also been shown to be an anti-oxidant for butter fat by Govindarajan and Banerjee (20), and for butter fat and vegetable oil shortening by Dhar and Aggarwal (21). But it is observed that though kamala dye is odourless and harmless, it imparts a yellow colour to the oil, in the amounts recommended.

The effect of ascorbic acid, previously thought to be antioxygenic, is now well established to be synergistic to the phenolic antioxidants present or added externally to the fats. (22, 23 and 35). Its poor solubility in fats has been overcome by the use of its fatty acid esters. (24, 25).

Kaloyereas (26), in 1947, found out that the alcoholic extract of anise seeds worked as antioxidant to olive oil. Antioxygenic properties have been reported in cereal and oilseed flours by Green and Hilditch (27) and Hilditch and Paul (28). Sesame seed powder was shown to protect butter fat and vanaspati by Dhar and Aggarwal (21). A comprehensive study of several Indian spices for their antioxidant behaviour towards butter-fat and edible vegetable oils led Sethi and Aggarwal (29, 30) to the conclusion that though most of the ground spices had the desired effect to a lesser or greater degree, the following spices were specially effective: red chilli, cinnamon leaf, turmeric, clove, black pepper, nutmeg fruit, and betel leaf. They also reported that the antioxidant principles present in spices are heat-stable. Chipault *et-al* (31) working almost simultaneously proved that although all the thirty-two ground spices and their alcoholic and petrol ether extracts tested by them had some degree of antioxidant activity on prime steam lard, rosemary and sage had particularly pronounced effects. Earlier, Ramaswami and Banerjee (32) found that curcumin is responsible for the activity of turmeric. Aca-catechin extracted from crude catechu (kathai) inhibits oxidation of vegetable oils as reported by Husaini and Saletore (33). Antioxidant properties of the extracts of a number of spices including cinnamon, all-spice, thyme, cayenne, clove, rosemary, sage etc. were also confirmed by Egli *et al* (34).

A systematic search for finding out the ingredient actually responsible for the antioxygenic behaviour of spices was then started by various workers. Ascorbic acid in red chilli, eugenol and isoeugenol in cloves were shown to be the active principles by Sethi and Aggarwal (35). Capsaicin, the pungent principle of red chilli was found to be inactive by these workers. The antioxidant activity of black pepper was attributed to tocopherols (36).

Recently hydroxy-chavicol or 1, 2—dihydroxy 4—allyl benzene isolated from the betel-leaf (**Pan,**—Hindi piper betle Linn) has been found to be a very effective antioxident (35). It is a white crystalline solid m.p. 48.5°C, soluble in water, alcohol, and fats. It can be easily obtained from the alcoholic extract of betel leaves by treating it with dilute alkali, removing the neutral portion with ether, acidifying the alkaline solution and extracting it with ether, and crystallising the products so obtained from ether-petrol ether. It is claimed that hydroxy chavicol is as effective in preservation of lard and vegetable oils as any of the well known antioxidents. Its activity is increased considerably in presence of acid synergists.

As hydroxychavicol is quite soluble in fats and does not impart any colour, odour or taste in the amounts found effective, it seems to be a valuable antioxidant that may be cheaply produced in India.

### TABLE I.*

**A.O.M. Tests (37) with various antioxidants on refined lard.**

| Substance added and % Concentration. | | Stability index** |
|---|---|---|
| 1. | N. D. G. A. 0.01 | 32 |
| 2. | N. D. G. A. 0.05 | 45 |
| 3. | N. D. G. A. 0.01 + citric acid 0.01 | 42 |
| 4. | Propyl gallate 0.05 | 50 |
| 5. | Propyl gallate 0.05 + ascorbyl palmitate 0.06 | 73 |
| 6. | Hydroxy-chavicol .01 | 35 |
| 7. | Hydroxy-chavicol .03 | 46 |
| 8. | Hydroxy-chavicol 0.03 + citric acid 0.01 | 58 |
| 9. | Hydroxy-chavicol 0.03 + ascorbyl palmitate 0.06 | 60 |

### TABLE II.*

A. O. M. Tests (37) with various antioxidants on refined groundnut oil.

| Substance added in % concentration. | Stability index** |
|---|---|
| Propyl gallate 0.03 | 5.0 |
| Propyl gallate 0.03 + ascorbyl palmitate 0.06 | 6.4 |
| N. D. G. A. 0.05 | 2.7 |
| N. D. G. A. 0.05 + ascorbyl palmitate 0.06 | 5.0 |
| Butylated-hydroxy anisole 0.03 | 2.6 |
| Butylated-hydroxy anisole 0.03 + ascorbyl palmitate 0.06 | 5.84 |
| Hydroxy chavicol 0.025 | 3.8 |
| Hydroxy chavicol 0.025 + ascorbyl palmitate 0.06 | 7.6 |

** Stability index is the ratio of the time taken to reach the peroxide value of 20 m. equivalents/kg. by the fat to which antioxidants have been added, to the time taken to reach the same peroxide value by the blank.

* In tables I & II, comparative antioxidant properties of some new and old substances have been given.

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# CHEMISTRY

# &

# ANALYSIS

# COMPOSITION OF THE FIXED OIL OF DELPHINIUM STAPHISAGRIA L. SEEDS (Stavesacre).

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**The fixed oil from Delphinium staphisagria (Ranunculaceae) seeds, commonly known as "Stavesacre", is reported to be useful as a pediculicide and possesses an unusual fatty acid composition. The oil contains calcium iso-oleate, and elaidic, oleic, linoleic, acetic and benzoic acids. The absence of glycerine suggests that the fatty acids are present not as glycerides but in combination with some aminocyclic polyhydric compound.**

It is universally reported that the seeds of D. Staphisagria L. contains a high percentage of a fixed oil. To some extent it can be expressed mechanically but for complete removal, extraction with a suitable solvent is essential. Of all the solvents that have been tested, light petroleum and ether are found to give the most satisfactory results. These solvents remove the oil more or less completely and at the same time carry along a minimum of impurity.

The concentrated ligroin extract, on standing in the refrigerator for some time prior to the separation of the alkaloids by extration with dilute sulphuric acid yields a white crystalline compound. Markwood (1) has also reported the presence of such a substance and recognised it as a calcium salt of a fatty acid. He made a suggestion that the acid component of the calcium salt may be the C$_{17}$ acid of the acetic acid series, "known variously as daturic, or margaric, or simply as heptadecylic acid." He observed that this conclusion was presented only tentatively and more work was needed to establish this point.

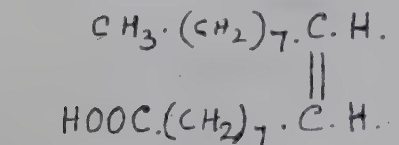
This crystalline compound has now been characterised as calcium iso-oleate, a structural isomer of oleic or elaidic acid. This is insoluble in ether and light petroleum but dissolves in the seed oil as well as in ether-oil and light petroleum-oil mixtures.

Markwood (loc. cit.) separated the alkaloidal portion(2) by treating the oil with 5 per cent sulphuric acid. He then expelled the last traces of ether by heating it to 120° under diminished pressure and carried out the determination of some physical constants as given below:

| | |
|---|---|
| Specific gravity 20/4 | 0.891 |
| Refractive index at 20° | 1.462 |
| Acid value | 92.8 |
| Iodine No. (Hanus) | 80.2 |
| Saponification value | 190.0 |
| Acetyl value | 12.8 |
| Unsaponifiable matter | 2.92 % |

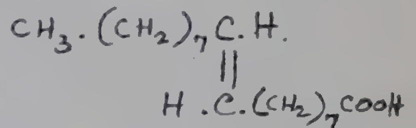
The alkaloid-free oil has been closely studied, the major and minor components separated and the identity of each individual established. At the outset the unsaponifiable material is removed from the oil by effecting the saponification of the latter with methanolic potassium hydroxide solution, when, remarkably enough, the presence of glycerol or any hydroxy compound could not be detected. On the other hand, by dissolving the soap in dilute sulphuric acid and extracting with ether the oil is regenerated. This nevertheless, gives two distinctly different fractions on fractional distillation under reduced pressure.

Fraction I — At 170-172°/0.5-1 mm.
Fraction II — At 245-248°/0.5-1 mm.
Fration I gives (a) elaidic acid, m.p. 51-52°
(b) oleic acid, m.p. 14-16°.



$$\begin{array}{c} CH_3\cdot(CH_2)_7\cdot C\cdot H \\ \| \\ HOOC\cdot(CH_2)_7\cdot C\cdot H \end{array}$$

Oleic, cis-$\Delta^9$-octa decenoic acid.

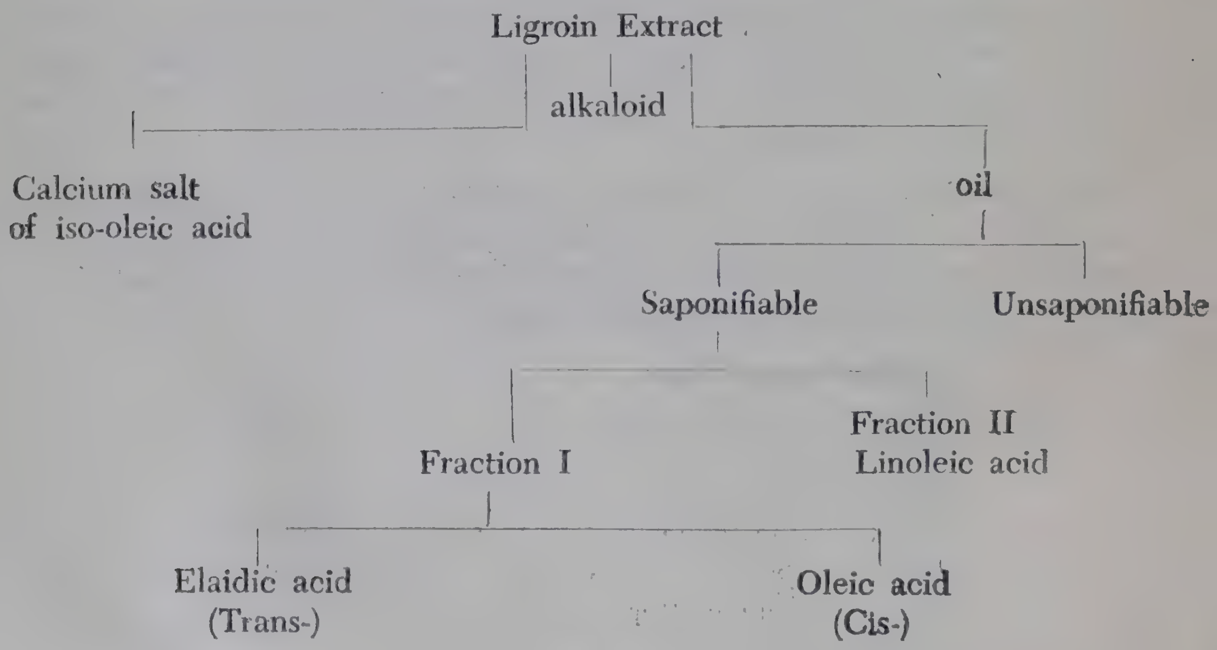


$$\begin{array}{c} CH_3\cdot(CH_2)_7 C\cdot H \\ \| \\ H\cdot C\cdot(CH_2)_7 COOH \end{array}$$

Elaidic, trans-$\Delta^9$ octa-decenoic acid.

It follows, therefore, that both cis-and trans-forms of oleic acid exist at room temperature but on distillation at 170-172°/0.5-1 mm., they behave as a single homogeneous substance. Even then it cannot be said with any certainty whether both forms exist in the seed or an isomeric conversion of one into the other takes place during the various processing operations, viz., extraction, treatment with acid, saponification and distillation upto 170-172°/0.5-1 mm.

Fraction II — (a) Linoleic acid 2 C=C.
(b) 30% could not be worked up.

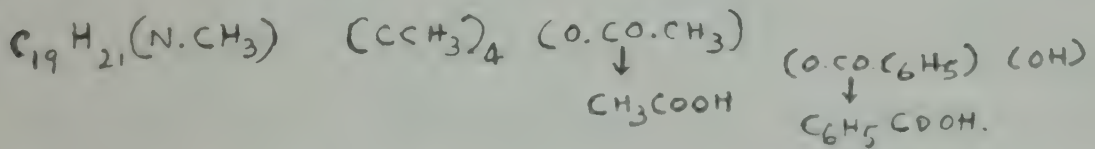


**Mode of occurrence of the alkaloids in the seeds.**

All attempts to isolate the basic material from the acetone solution of the seed extract by the low temperature fractional crystallisation process have been totally unsuccessful. Chromatography or any other physical methods so far attempted have not affected the separation of the alkaloids from the fatty material. There is no convincing evidence that the alkaloids exists as free bases dissolved in the stavasacre oil. It is only on vigorous agitation and exhaustive treatment with dilute acids that the extraction of the alkaloids is possible.

Hence, from the above observations coupled with the fact that glycerine is entirely absent, it appears likely that delphinine and other alkaloids do not form a mere solution in the mixture of unsaturated fatty acids. This conclusion suggests that the latter plays a part more significant than a simple solvent.

It is fitting to quote here the most recent observations of Gunde and Hilditch (2, 3) and of other groups of workers (4, 5, 6) that a few plants have been found to possess unusual features in the content of their seed fats. In addition to the usual higher fatty acids, appreciable proportions of formic, acetic and benzoic acids are present not as "GLYCERIDES" but in combination with a complpex polyhydric and probably cyclic alcohol the exact nature of which is as yet unknown. In the light of this fact, it may likewise be stated that in addition to the higher fatty acids (oleic, elaidic, linoleic, etc.) acetic and benzoic acids are present not as "Glycerides" but in combination with an amino-cyclic polyhydric compound (which may be delphinine) of which very little beyond the functional groups is known.



$$C_{19}H_{21}(N.CH_3)\quad (CCH_3)_4\quad \underset{CH_3COOH}{\underset{\downarrow}{(O.CO.CH_3)}}\quad \underset{C_6H_5COOH.}{\underset{\downarrow}{(O.CO.C_6H_5)}}\ (OH)$$

There is a possibility that the potential hydroxyl groups of delphinine may combine in some way with the fatty acids or that the basic nitrogen atom may give rise to an additive salt. It is also possible that some unusual phenomenon of resistant solubility may be operating between the bases (delphinine, staphisine, etc.), and the fatty acids or their calcium salts.

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# "SEED OIL FROM MALLOTUS JAPONICUS MUELL. ARG."

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Seed oil from Mallotus japonicus Muell. Arg. has not hitherto been studied at all, although Kamala oil obtained from a kindred plant, **Mallotus philippinensis Muell. Arg.**, has recently been studied intensely since a new acid, kamlolenic acid (18-hydroxy-9, 11, 13-octadecatriencic acid)(1) was separated from this oil as the chief component of fatty acids.

Some data on the seed of Mallotus japnonicus used for the extraction of oil in the present study are shown in Table 1. The seeds were stored for one or two months after their harvest and ground immediately before the extraction with other. The ether-extract was treated with about tenfold acetone or hexane, the insoluble portion was removed, and the acetone-soluble or hexane-soluble oil was obtained from the solution by removing solvent.

**Table 1. Some Data on the Seeds of Mallotus japonicus used in the present Study.**

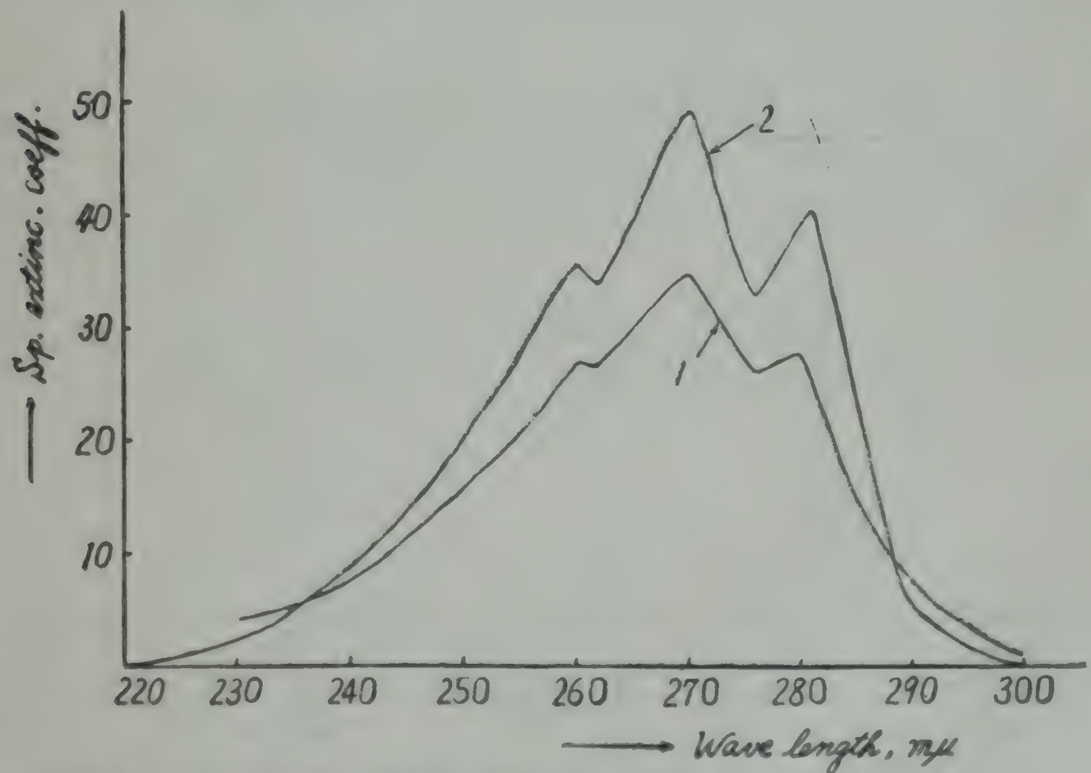
| Sample No. | | 1 | 2 |
|---|---|---|---|
| Growing place | | Yokkaichi City | Yokkaichi City |
| Date of harvest of seeds | | Early Sept. 1953 | Early Sept. 1954 |
| Total weight of seeds | (g) | 21.2 | 294 |
| Ether-extract | (g) | 9.5 | 122 |
| | (%) | 44.8 | 41.5 |
| Acetone-soluble oil | (g) | 9.2 | — |
| | (%) | 43.4 | — |
| Hexane-soluble oil | (g) | — | 102 |
| | (%) | — | 34.7 |

Characteristics of the acetone-soluble oil (Sample No. 1) and the hexane-soluble oil (Sample No. 2) are given in Table 2. Iodine values recorded in the present paper were determined by the Wij's Method.

Table 2. Properties of Oil.

| Sample No. | 1 | 2 |
|---|---|---|
| Appearance at ordinary temp. | Light yellow liquid with a little solid | Light yellow liquid with solid |
| Sp. gr. ($d_4^{20}$) | 0.9358 | 0.9275 |
| Refr. index ($n_D^{20}$) | 1.4925 | 1.4862 |
| Acid value | 6.4 | 33.8 |
| Saponif. value | 195.5 | 199.0 |
| Iodine value | 121.4 | 110.0 |
| Unsaponif. matter (%) | 0.72 | 0.63 |
| Fatty Acids | | |
| Refr. index ($n_D^{30}$) | 1.4795 | 1.4731 |
| Neutralization V. | — | 204.7 |
| Iodine v. | — | 112.0 |
| Acetyl value of methyl esters of fatty acids | 17.9 | 38.4 |

The fatty acids from both oils show ultravoilet absorption curves (fig. 1) which have the absorption maxima characteristic to conjugated triene. The methyl esters of both oils have relatively high acetyl values as shown in Table 2. From these facts, seed oil of Mallotus japonicus, like Kamla oil, is suspected to contain kamlolenic acid.



Curve 1 for the fatty acids of acetone-soluble oil (Sample No. 1).
Curve 2 for the fatty acids of hexane-soluble oil (Sample No. 2).

**Fig. 1. Absorption Curves of the Fatty Acids:**

The hexane-insoluble fraction obtained by treating the ether-extract (Sample No. 2) with hexane was a viscous oil and turned into a gel after standing for a few days, which had acid v. 7.7, saponif. v. 201.5, iodine v. 115.7 and unsaponif. matter 0.14% and was considered to be a polymerized product of the glycerides rich in kamlolenic acid.

For the experiments described below, the fatty acids from the hexane-soluble oil from Sample No. 2 was used.

Bromination of the fatty acids gave no ether-insoluble bromide but hexane-insoluble bromide which had m.p. 114°-115°C after recrystallization from 90% ethanol and was identified with tetrabromostearic acid by the mixed melting point test.

The fatty acids (80 g) were dissolved in 700 cc of acetone, and the solution was neutralized with 125 cc of an aqueous solution of lithium hydroxide (concentration, 5.6%) and then diluted with 300 cc of acetone. The solution was cooled with ice, and the precipitate of lithium soap formed was filtered. The fatty acid fraction (67 g) from the precipitate had $n_D^{30}$ 1.4681, iodine v.108.5 and $k_{270}=43.3$, while the fatty acid fraction (12 g) from the filtrate had n 1.4708, iodine v. 110.5 and $k_{270}=50.3$. The fatty acid fraction from the precipitate was dissolved in ethanol and fractionally precipitated in the form of lithium soap by adding a solution of lithium hydroxide in successive portion. The results are shown in Table 3.

**Table 3. Fractional Precipitation of Lithium Soap.**

| Fatty acid fraction | Yield (g) | Neutr.v. | Iodine v. | After recrystallization from ethanol. | |
|---|---|---|---|---|---|
| | | | | Neutr. vs. | Iodine v. |
| 1. | 6.5 | 205.6 | 32.6 | 212.0 | 7.4 |
| 2. | 5.2 | 205.7 | 54.7 | 213.7 | 7.0 |
| 3. | 7.0 | 204.0 | 51.2 | 206.4 | 20.0 |
| 4. | 2.8 | 199.6 | 91.6 | — | — |
| 5. | 5.5 | 204.0 | 110.5 | — | — |
| Fraction from the final filtrate ... | 34.0 | — | — | — | — |

As is seen from Table 3, since the fatty acid fractions 1-3 have still noticeable iodine values even after recrystallization from ethanol, they are considered to be contaminated with some solid unsaturated acids. When the fatty acid fraction obtained from the final filtrate was mixed with 200 cc of hexane, it dissolved partly in hexane while a considerable amount of crystalline solid and a small amount of yellowish oily liquid separated from the solution. Ether was added to the mixture until the crystalline solid completely disappeared. The clear solution was separated from the yellowish oily liquid and cooled with ice, giving about 4 g of crystalline substance which was recognized as ∝-kamlolenic acid by its m.p. 72°-73°C, neutr.v.192.5 and iodine v.178.1 after recrystallization from ether-hexane (∝-kamlolenic acid m.p. 78°-79°C: (1) 72°-75°C: (2) neutr. v., calcd., 190.6; iodine v., calcd. 258.6. The Wij's method gives an iodine value corresponding to about two-thirds the calculated value). To the mother liquor of recrystallization of ∝-kamolenic acid was added a bit of iodine, and the solution was allowed to stand over a night. The crystalline substance formed was separated and recognized as β-kamlolenic acid by its m.p. 87°-89°C (β-Kamlolenic acid: m.p.90°-92°C (1), 85°-87°C(2).

∝ and β-kamlolenic acids obtained above were united and the united material was hydrogenated in ethanol in the presence of platinum black. The product, after recrystallization from ether, showed m.p. 98.5°-99°C and neutr. v. 184.5, and its acetyl ester had saponif. v. 299.8 (hydroxy-octadecanoic acid; m.p. 99°-100°c; (1) neutr. v., calcd., 186.7; saponif. v. of the acetyl ester, calcd., 327.6). Somewhat low saponification value of the acetyl ester may possibly be ascribed to the difficulty of a complete acetylation of hydroxy-octadecanoic acid due to some side reactions such as self-esterification. The hydrogenation product was oxidized with chromic acid in glacial acetic acid, and the oxidation product was washed with hexane and then recrystallized from acetone, yielding hexadecamethylene-1, 16-dicarboxylic acid in a crude form: m.p. 116°-118°C and neutr. v. 346.9 (m.p. 125°-126°C (1), for the pure substance; neutr. v., calcd., 341.6).

Ultraviolet absorption values for ∝ and β-kamlolenic acids were measured in methanol. In Table 4, our data are compared with those previously reported. It may be noteworthy that the specific extinction coefficient for β-kamlolenic acid obtained by us is considerably higher than the corresponding data by previous authors.

**Table 4. Ultraviolet Absorption Values for ∝ and β-Kamlolenic acids.**

| ∝-Acid | | β-Acid | |
|---|---|---|---|
| Wave length (m μ) | Absorption value | Wave length (m μ) | Absorption value |
| 270 | k = 177.8 | 268 | k = 226.1 |
| 271 | $E^{1\%}_{1cm}$ = 1,750 | 269 | $E^{1\%}_{1cm}$ = 1,880 (2) |
| 270.5 | $E^{1\%}_{1cm}$ = 1.800 | 268 | $E^{1cm}_{1\%}$ = 1,999 (3) |
| 271 | k = 167.5 | 268 | k = 186.0 (4) |
| 271 | $10^{-3}_{\epsilon}$ = 52.0 | 268 | $10^{-3}_{\epsilon}$ = 60.0 (5) |

Note : The specific extinction coefficient for $\alpha$-acid obtained by us was measured with a sample which had been stored in the form of an ether solution for several days in the dark after its preparation. In a preliminary measurement with a sample of $\alpha$-acid immediately after its preparation, a very high value, $k_{270} = 233.0$, was obtained. Since kamlolenic acid is liable to undergo some change during its storage, even when stored cautiously, it is not quite excluded that the higher absorption value is the real one. In this respect, the authors are going to make a closer study.

## Summary :

Oil was extracted from the seeds of **Mallotus japonicus Muell. Arg.,** and its characteristics were determined $\alpha$-Kamlolenic acid was separated from the fatty acids of this oil. The content of kamlolenic acid in this oil appears, however, to be smaller than that of Kamala oil from **Mallotus Philippinesis Muell. Arg.**

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# FRACTIONATION OF FATTY MATERIAL WITH UREA

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**The chemistry of intermolecular compounds with special reference to those formed by fatty material with urea, has been fully discussed. The combining proportions of urea and fatty materials, stability of complexes and their behaviour in different solvents like methanol, ethanol and water and the mode of fractionation are dealt with. The adduct forming property of urea is used for enrichment, estimation and detection of particular component and for finding out the composition of various vegetable and marine oils. The fundamental basis for the fractionation is obtained by studying the separation of binary mixtures of fatty acids. Three techniques (a) stepwise addition of urea, (b) solvent decreasing crystallization and (c) urea adduct elution are developed for the fractionation of mixed fatty acids. The compositions arrived at by these methods fairly agree with those found by traditional procedures. In the case of fish oils, the composition is calculated graphically from the unsaturation and chain length curves. The limitations of various separation processes such as, lead-and lithium-salts, low temperature crystallization, distillation, chromatography and counter current distribution techniques are given and the possibility of the effective application of urea to increase the resolving power has been indicated. (39 references).**

Urea binds straight chain organic substances to form molecular compounds, which do not obey the basic laws of chemical combination and electronic theory of valency. The study of the crystal structure of these crystaline molecular compounds is of great interest. It was found by Smith (34.35), in the x-ray study of single crystals, that the complex is the hexagonal, whereas urea itself is tetragonal. In forming the complex the urea molecules build up in a channel like unit cell in a helical way. The straight chain organic molecule attaches itself to urea by the van der Waal's forces or induced electro static attractions. About the dimensions of urea cells, Schlenk Jr.(31) gives maximum value of approximately 5.5A° for the available diameter, the channel being 6.0A° at its widest part and 5.0A° at its narrowest. It is generally accepted that each carbon atom of organic molecule requires about 0.7 mole of urea to bind. From the dimensions of the crystal structure an idea about the substances capable of forming complexes can be obtained which would be helpful to fractionate mixtures of straight chain molecules. The separations are mainly based on the differences in the chain length, degree of unsaturation, and branching. This paper deals with the combining proportions, properties and conditions of formation of these intermolecular compounds. In the analytical field, their utilization for the segregation, estimation and finding out the composition of different fatty materal by fractionation has been fully discussed.

Redlich, Gable, Dunlop and Millar (26) have developed methods for determining the equilibrium constants of decomposition or formation of complexes. Newy, Shokal, Muellar, Bradley and Fetterly (25) found this urea method better than the usual classical methods for the separation of the mixed fatty acids of soyabean and linseed oils in two fractions of higher and lower iodine values than that of the original mixed fatty acids. Schlenk and Holman, (29,30) by the proper selection of proportion of urea segregated pure oleic acid (97-98% purity and 40% yield) from fatty acids of olive oil. The differences in yields of crystalline complexes from various fatty acids under standardised conditions suggested that prediction could be made for the separation of components of the mixture.

In the preliminary work(13) to separate mixed fatty acids of sesame and linseed oils it was found that the adduct formation can be controlled by the amount of concentration of urea and the exess of solid urea available for reaction. Methanol, as solvent, has been found to be more efficient than water. The fractions of highly unsaturated fatty acids containing fair amount of linolenic acid (I.V. 232-234) were obtained. Coleman, Knikht and Swern (6) used urea for obtaining highly concentrated fractions of methyl oleate peroxide (nearly 70-90% purity).

To find out whether the hydroxy aliphaitic compounds to form adducts or not, castor oil fatty acids were fractionated by urea (14). The results indicate that ricinoleic acid definitely forms complex with urea contrary to the results obtained by Saletore and Achaya (2). Ricinoleic acid of 91% to 95% purity was obtained, as the separation is not sharp due to the presence of acids having same carbon chain length. The non-adduct forming property of urea with the branched chain acids was used with an advantage to obtain ricinoleic acid (98-99% purity and 64% yield) from acetylated castor oil fatty acids. According to Swern, Withnaur and Knight (36) detection and configuration of 9 : 10 dihydroxy stearic acid (m.P.95°C) was possible by urea. Studies on adducts of hydroxy acids by Catravas and Knafo (45) show that di-hydroxy and tri-hydroxy stearic acids can be precipitated.

A fraction rich in iso-oleic acid from "Dalda" brand Vanaspati fatty acids was obtained first by standard lead-salt-alcohol method and then by urea in presence of alcohol (95%) (15). The adduct containing 56.8% saturated acids and 43.2% iso-oleic acid was obtained and the raffinate had the composition as 36.6% saturated and 63.4% iso-oleic. In the separation of binary mixtures of unsaturated acids as elaidic, oleic and linoleic with the saturated acid series it was noticed that elaidic acid has greater tendency to form an adduct than oleic and linoleic acids, while linoleic acid can more easily be separated than oleic and elaidic acids from mixtures with saturated acids (24). It was of interest to determine whether elaidic acid could be separated from stearic acid by urea inclusion method (11). The separation of mixture containing stearic and elaidic acids in the proportion of 1:1 showed that the adduct contained 76.1% of stearic acid, rest being elaidic acid. The adduct forming tendencies of elaidic and saturated $C_{14}$, oleic and saturated $C_{18}$ acids are more or less the same (24). The "trailing in" effect of unsaturated acids with lower saturated acids was observed and hence the necessity of repeated fractionation to obtain 100% pure acids.

For enrichment of a particular acid or acids by urea Abu-Nasr, Potts and Holman (1) segregated highly unsaturated acids from mixed fatty acids of various fish oils. In our laboratory at the same time rich fractions of highly unsaturated acids and esters from Indian shark liver oil were obtained (16). The fractionation was carried out by stepwise addition of urea in presence of ethanol and methanol. The iodine values and saponification equivalents for the various fractions were determined in order to investigate the effect of unsaturation and chain length in urea-complex formation. The weight ratios of urea to fatty acids and esters have also been studied and it was noticed that increase in chain length and unsaturation requires more urea to bind due to the steric irregularities in the acid chain. Silk, Sephton and Hahn (33) concentrated highly unsaturated acids and alcohols from South African pilchard oil. This urea technique was compared with the lithium salt-acetone segregation method and it was concluded that urea separated acids of high average unsaturation rich in $C_{16}$—$C_{18}$ while lithium-salt-acetone procedure affords the separation of low average unsaturation with longer chain lengths.

The formation of complexes of various aliphatic straight chain compounds with urea can be used for estimation of certain compounds which do not form edducts and also for the detection of adulterants. A method for the quantitative estimation of rosin in soaps has been devised by Sharma (32). Rosin being cyclic compound does not form complex with urea and it is estimated in the non-adduct forming portion by titrating the raffinate with alcoholic potassium hydroxide solution. The application of this technique has been compared with the McNicoll (12) method and the results are in excellent agreement in case of commercial household and toilet soaps.

The presence of higher acids such as arachidic, behenic and lignoceric in groundnut oil fatty acids and erucic acid in mustard oil makes possible their detection in other oils. The adulteration in mustard oil with groundnut and linseed oils was estimated by concentrating the higher acids by a single dose urea method (23). Various proportions of mixed oils, urea and alcohol were used and the concentrates obtained were analysed fir erucic acid. It was found that yields of $C_{22}$ unsaturated acids varied directly with the percentage of adulterant.

Besides the study of conditions of complex formation, attempts have been made to arrive at the composition of different vegetable and marine oils by urea fractionation. The solvent medium which is used for different oils is mainly either ethanol or methanol. For finding out the composition of the mixed fatty acids three different techniques of fractionation have been developed by us. The first method used is "stepwise urea addition" in which urea is added successively to get the crystalline crops. The various fractions obtained are decomposed to give fatty acids and are analysed. The second "solvent decreasing crystallization" method consists of preparing a mixture of fatty acids with urea in enough amount of solvent, so that the urea is sufficient to bind all acids. Successive fractions are then obtained each time by distilling off a limited amount of solvent. The adduct formed with the available urea is then removed. In the third "elution technique", complete adduct of the mixed fatty acids is prepared by the addition of urea (four times the weight of acids) with the least amount of solvent and each time a fraction is obtained by eluting the adduct with a limited amount of solvent. The advantage of this last technique is that it is easy to handle the crystalline adduct compared to the first two methods and the repeated heating of free acids is avoided. In this the loosely bound and unstable adducts of the most unsaturated molecules are dissolved in the first fractions, while in the former two methods the saturated acids of long chain lengths which readily form most stable complexes separate out first. The fractions obtained by the respective methods are decomposed by warm acidulated water after the removal of solvent and the fatty material is recovered with ether. Iodine and saponification values are determined for each fraction. The composition is then calculated by the method recommended by Hilditch (10).

The fatty acid composition of Dalda (Vanaspati) acids by stepwise urea addition and solvent decreasing crystallisation methods was obtained (15). The results are comparable with those obtained with iodine and thiocyanogen values and low temperature crystallization and ester fractionation methods (3). Further, the same urea procedure was adopted with the mixed fatty acids of mustard oil which contains erucic, oleic, linoleic and linolenic acids with saturated acids having a long range of carbon chain lengths from $C_{16}$-$C_{24}$ (17). By the solvent decreasing crystallization method the composition arrived at compares well with the composition of common variety of mustard oil. During the fractionation erucic acid of 93% purity was obtained (43% yield). Higher purity was not possible because of the tendency of the lower saturated acids to form complexes simultaneously. It was also of interest to find out if the soaps of fatty acids would form adducts with urea. Hence the fractionation of potassium soaps of mustard oil fatty acids was carried out by the stepwise addition (21). It was found that soaps do form adducts and the composition of mustard oil fatty acids can be calculated from these fractions.

The mode of formation of urea complexes with lower homologous saturated acids can be best studied by fractionating fatty acids of coconut oil or similar fats. The decreasing solvent crystallization and the elution methods were applied to the methyl esters of coconut oil (18). The limitations of the urea adduct method do not allow the correct calculations of the compositions of the fatty acids lower than $C_{12}$. Results of fractional distillation of fatty acids and their methyl esters show that the last few fractions and the residue consisting of palmitic and stearic acids were also rich in oleic acid. The obvious cause of this is that the differences in the boiling points of palmitic, stearic and oleic acids are very small.

Groundnut (peanut) oil which has considerable percentage of higher saturated fatty acids namely arachidic, behanic and lignoceric was chosen for fractionation study by Mehta, Kokatnur and Dabhade (19). Methyl esters of groundnut oil fatty acids were fractionated by decreasing solvent cdystallization method and the mixed fatty acids by the urea adduct elution technique. By the former method the arachidic and behenic acids were detected upto the extent of 4.9%.

Among the natural fats the investigation of compositions of the mixed fatty acids of marine oils is still in its early stages. The fish oil fatty acids are complex mixtures of homologous acids from $C_{12}$ to $C_{24}$ with different degree of unsaturation and isologous acids. Till now compositions were arrived at by means of fractional distillation of esters after a preliminary separation by the lead and lithium salts. To find out the composition and to separate the highly unsaturated acids, liver oils from different species of sharks were selected for study (22). The carbon chain length and mean unsaturation of each fraction were determined from its neutralization and iodine values. The integral graphs were obtained by plotting the carbon chain length and mean unsaturation of each fraction against the percentage acids in the successive elutes. The compositions were calculated by intergrating the respective curves and distributing the fatty acids according to chain length and unsaturation. The separation here was primarily according to unsaturation and secondarily according to chain length. The empirical representation of the composition was done in two ways as it is not possible to give rational and unambigous composition of the marine oils due to the complex nature of acids of which the chemistry has not been fully explord. In the traditional method the mean unsaturation is assigned to the different chain lengths and in the other, mean chain length is assigned to mono-, di-, and tri-unsaturated acids. Hanson (8) also showed that the results of separation of methyl esters of fish oils by low temperature cystallization combined with molecular distillation agreed substantially well with the urea fractionation.

The adoption of specific method to resolve components of a mixture should be flexible depending on the nature and constituents of the mixture. The fatty acid mixtures of various fats and oils are too complex to be resolved by using a single separation procedure. Because the lower saturated acids have the tendency to from complexes along with the acids like oleic, the difficulty arises in urea fractionation as in the case of coconut oil fatty acids. Elaidic saturated $C_{14}$ and oleic-saturated $C_{16}$ are very difficult to resolve because the effective carbon chain length is reduced considerably in unsaturated acids. To avoid the complications in the fractionation, the lower saturated components may be removed by some other technique and then followed by urea fractionation.

The preliminary concentrates of saturated acids, monoethenoids and polyethenoids from the total mixed fatty acids, is usually achieved by the methods based on the relative solubility of the metallic salts of saturated and unsaturated acids in various solvents and this separation cannot be varied at will. Of such methods, standard lead-salt-alchol method provides separation of saturated acids which are always accompanied by considerable quantities of unsaturated acids. Similarly, even though lithium-soap-acetone procedure of Tsujumito has been claimed to be the most efficient for the separation of monoethenoids from polyethenoids especially in marine oils, the latter do appear in the monoethenoid portion. By varying the amount of urea and solvent at different temperatures, the separation can be controlled and here the flexibility of the process is of advantage in obtaining the desired fractions. In this laboratory monoethenoids were separated from the polyethenoids by the addition of urea to the soluble lead-salts in alcohol, after removing the insoluble portion. The results showed that the soluble lead-salts do form adducts and almost all monoethenoids are separated.

In distillation of fatty acid mixtures containing large proportion of polyunsaturated acids in fish oils thermally induced polymerization has been demonstrated by many investigations on fish oils. The possibility of structural alterations due to heat was also early recognised by Vandenhueval (38, 39). Even with the recent developments in efficient columns with very small pressure drop the possibility of thermal modifications still exists. These difficulties can be avoided if the separation is carried out by urea adduct elution. It can be done at ordinary pressure and temperature, avoiding the alterations as the complexes are less prone to oxidation Schlenk (27-29) suggested that the fatty molecules occupy a restricted space in the lattice of the crystals and probably offers a barrier against the free penetration of oxygen.

Amongst the milder separation techniques, wherein the possibility of structural alteration is excluded, are low temperature crystallization, counter current distribution and chromatography besides urea fractionation. Saturated and unsaturated acids having small differences in the boiling points of methyl esters of the same chain length make the separation difficult by fractional distillation. In this case the separation can be effected by either low temperature crystallization at as low as —70°C or by urea fractionation at room temperature. The efficiency of urea complex method has been contrasted with that of low temperature crystallization by Swern and Parker (37). Both the processes involve crystallisation and selectivity increases with the amount of solvent used. In the latter intermolecular compounds are formed during crystallization which are stable at comparatively high temperature.

The separation with urea can be very well compared with the counter-current distribution (7) and chromatographic techniques (9). In both the cases the separation of various homologous and isologous series of fatty acids and their derivatives is according to chain length and unsaturation. In the former the partition coefficients of the solutes play an important role in the separation and in the latter the absorbability of various substances by the physical forces makes the separation possible, while in urea fractionation the differential stability of the molecular compounds increases the resolving power.

The fundamentals of urea-adduct formation and their applications have opened a new field in fat chemistry. Since the substance remains included in a crystalline frame work of another molecular species the handling, manipulation, and storage of small and even large quantities of desired substances in industries are often considerably improved and simplified. It has also become an important and powerful tool in fractionation for findig out the components of various oils and fats. However, the success in achieving better separation of exceedingly complex mixture is most likely to result from the application of several fractionation methods along with urea in appropriate sequence.

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# UNSAPONIFIABLE MATTER IN KARANJA AND SESAME OILS

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Unsaponifiable matter in a Karanja Oil sample from Bangalore has been estimated spectrophotometrically and the isolated and intrinsic contents of karanjin and pongamol in the oil sample were noted.

A new compound has been worked up from the unsaponifiable matter of Sesame Oil (Sesamum indicum). Two varieties, viz. red and white sesame oils show different contents of the same new substance as was observed from their absorption spectra. The compound has been isolated from the alcohol extract of the oil as well as from the unsaponifiable fraction of the oil. The new compound has a molecular weight of 244 corresponding to the molecular formula $C_{[illegible]}H_{[illegible]}O_4$ and gives negative Baudouin test. This compound gives blue fluorescence in alcoholic solution. Both absorpiton and fluorescence spectra of the compound have been studied. The structure is under investigation. Baudouin test for the two varieties of the sesame oil has been studied colorimetrically.

Absorption spectra of both karanja and sesame oils have been studied in order to estimate the isolated compounds. Fluorescence spectra of the two oils, karanjin and the new compound (m. p. 120°) have also been studied.

## Unsaponifiable Matter in Karanja Oil :

Karanja oil contains a very high percentage of unsaponifiable matter. The presence of karanjin and ponganol in these oils has been previously reported (1. 3. 4.). In the present paper the author has estimated the presence of these substances by absorption and flourescence spectra of the compounds and attempted to extract the same from the oil by 90% alcohol. The results are given in the following table* and compared with the previous work. A special apparatus has been set up to extract these and other materials from the oil more completely.

TABLE NO. I

| *Source | Karanjin % | | Pongamol% | | Reference. |
|---|---|---|---|---|---|
| | Isolated | Estimated + | Isolated | Estimated + | |
| Oil | 1.0 | — | — | — | Limaye (3) |
| Oil | — | — | 0.1 | — | Rangaswami & Seshadri (4) |
| Oil (Talegaon) | 1.2 | 2.22 | 0.85 | 1.59 | Jatkar & Mattoo (2) |
| Oil (Bangalore) | 0.8 | 2.29 | 0.32 | 0.7 | Author |

+ Estimated Spectrophotometrically.

## Unsaponifiable Matter in Sesame Oil:

The unsaponifiable matter from sesame oil contains a class of compounds viz. sesamin, sesamolin and sesamol in addition to the sterols. Of all these constituents sesamol and sesamolin are known to be responsible for the Baudoin colour test. (5, 6).

The various components of the unsaponifiable matter in sesame oil reported so far are given below :—

### TABLE NO. II.

| Substance | m.p.°C | Molecular formula. | Molecular weight. | Reference. |
|---|---|---|---|---|
| Sesamin | 123° | $C_{20}H_{18}O_6$ | 354 | Boeseken (7) |
| Sesamolin | 94° | $C_{20}H_{18}O_7$ | 370 | Adriani (8) |
| Samin | 103° | $C_{13}H_{14}O_5$ | 250 | |
| Sesamol. | 65° | $C_7H_6O_3$ | 138 | |
| New compound | 120° | $C_{14}H_{14}O_4$ | 246 | Author. |

Baudouin Colour test for Sesame oil has been adapted by A.O.C.S. (9) for the qualitative detection of the oil. In our country also, the addition of 5% of sesame oil to margarine and vegetable products has been now made compulsory, to detect adultaration (10). The author has studied this reaction for the two varieties of sesame oil. The red colour developed by the oil with furfural and hydrochloric acid (d=1.153) has been studied on a Klet-Summerson colorimeter. The crimson red colour [absorption maximum at 510 m$\mu$ (fig. I)

GRAPH I

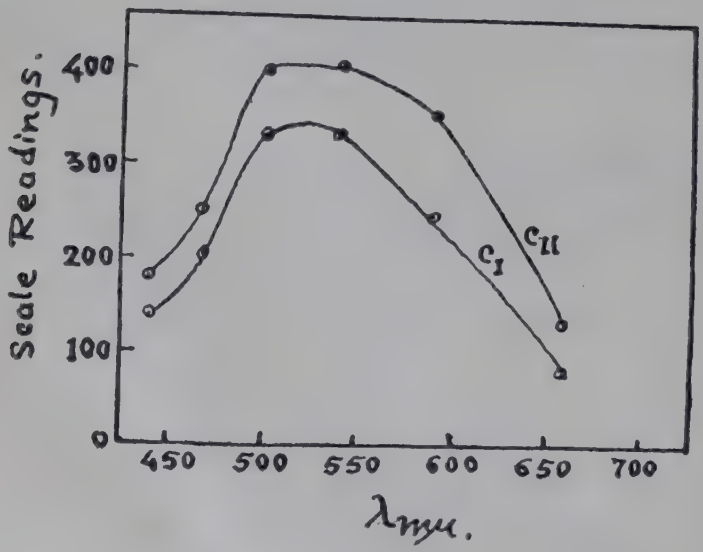

**Fig. I.**

**Absorption of the red-colour system (developed by sesame oil+HCl+furfural) measured on Klet-summerson colorimeter.**

which is in agreement with 518 m$\mu$ reported by Budowski (11).] develops with time, and the intensity of the colour for the same amount of oil varies with the concentration of hydrochloric acid and the quantity of the furfural added. The optimum conditions were found to be as follows :—

5ccs of the oil + 5cc con. HCl (d=1.153) + 0.3 cc of 1% furfural in alcohol.
Time : 60mins. (Fig. II).

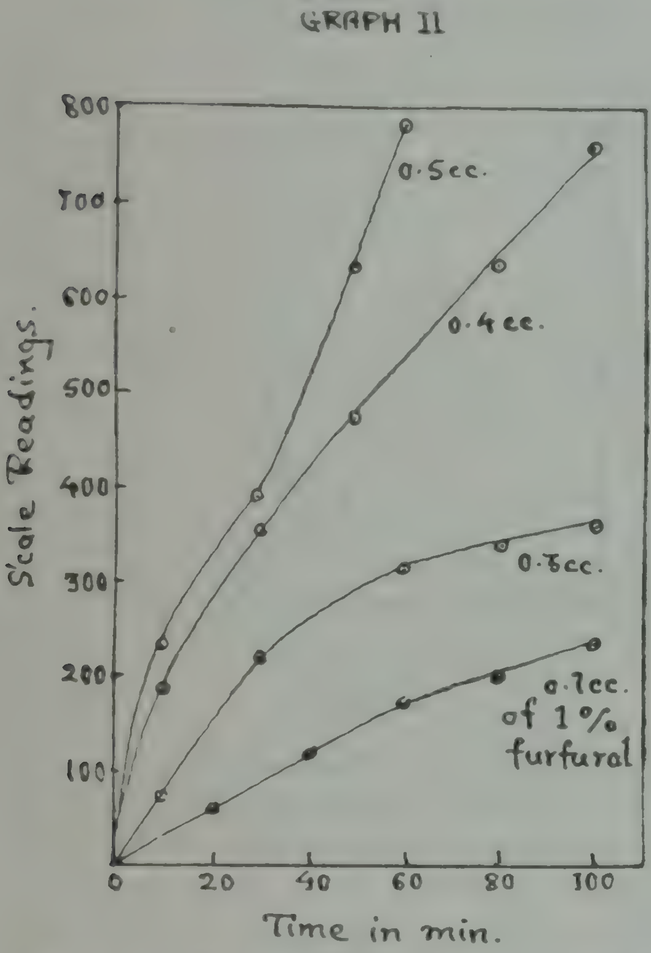

**Fig. II.**

**Effect of time and quantity of 1% furfural reagent [as added to 5c.c. of oil+5c.c. of Conc. Hcl (d=1.153)] on the Baudoin Test.**

With further increase in the quantity of the furfural reagent the colour develops faster but becomes unstable. Dilution with water destroys the colour.

In the present work two varieties of sesame oil (Sesamum indicum) viz. white sesame and red sesame were studied for their unsaponifiable constituents. Both the oils were extracted with alcohol until the extracted oil gave no Baudouin colour test. The acid value of the oil decreased after extraction. Thus the alcohol extract contained free acids, a little quantity of the oil, most of the colouring matter and the unsaponifiable constituents responsible for the Baudouin colour test.

The alcohol extract was saponified and the dried soap extracted with ether to separate the unsaponifiable part. From the ether extract a new crystalline compound was obtained. The same compound was recovered from the concentrates of the extract. The compound is a neutral, aromatic substance with a m.p. of 120°C. This compound does not give the Baudouin colour test Its molecular weight 244 corresponds to the formula $C_{13}H_{14}O_4$ and it contains 12% of methoxy group. In addition the compound gives a blue fluorescence in alcohol. Both absorpition and flurescence spectra of the compound were studied. The compound shows maximum absorption at 286 m μ and 240 m μ Fluorescene spectrum shows a maximum at 470 m μ (Fig. III).

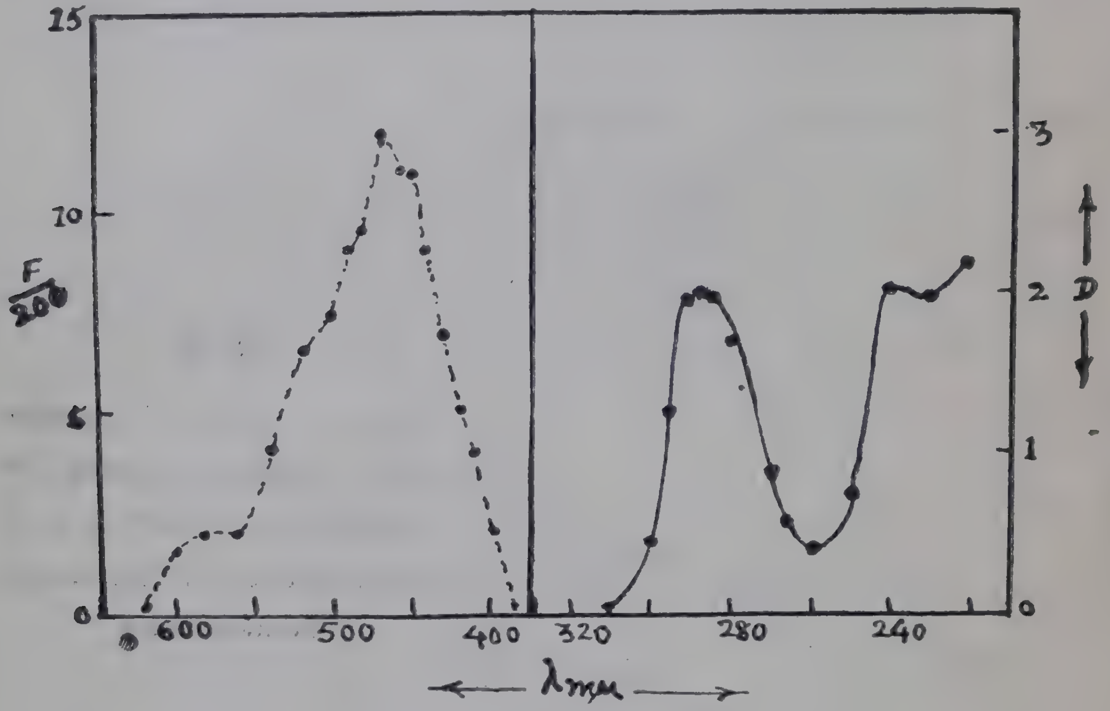

Fig. III.

**Absorption and fluorescence spectra of new compound m.p. 120°C.**

**● – – – ● fluorescence spectrum of the new substance, 0.26 g/l in alcohol.**

**●———● absorption spectrum of the new substance, 0.10 g/l in alcohol.**

The quantities of this compound as were recovered from the two varieties of oils differ, the red sesame oil being richer in this compound than the white one. The percentages of the compound were therefore spectrophotometrically estimated in the two oils. The red sesame oils contained 0.42% of this substance while the white sesame oil contained 0.18% only.

The structure of the compound is under investigation.

## Absorption and fluorescence spectra of Karanja and sesame oils.

**Absorption Spectra:** Absorption spectra of both Karanja and sesame oils have been studied in the present work, in order to estimate the isolated unsaponifiable constituents. Absorption measurements were taken on a DU Beckman spectrophotometer using spectrophotometrically pure alcohol as solvent. Karanjin and pongamol have been estimated by measuring the absorption of the oil in the region 340-380 m μ. Mattoo (2A) has shown that this region can be utilized for such estimation without any interference due to the absorption of the component fatty acids of the oil, the sterols and the colouring matter. The absorption spectra of pure karanjin and pongamol (in alcohol solution) have been measured to confirm the previous data. Then since the absorption spectrum of a mixture is in most cases, an additive function of the spectra of each component, the concentrations of the components can be calculated. The results thus obtained are given in the table. (Table No. 1).

Absorption spectra of the two varieties of sesame oil were measured in alcohol. It was noted that both the varieties showed remarkable absorption at 286 m μ. The new compound (m.p. 120°C) has also its absorption maxima lying at 286 and 240 m μs. Hence the new substance was estimated in the oil using the base-line method described by Wright. (12).

**Fluorescence spectra :** Fluorescence spectra of the Karanja oil, sesame oil and those of the isolated components have been studied using petrol (B.p. 60 - 80 fraction) and alcohol as solvents. Fluorescence spectra were measured on a fluorimeter constructed in this laboratory.

The fluorescence spectrum of karanjin in alcohol has been confirmed and has been shown to give maximum fluorescence at 460 m μ. Karanjin, however, gives no fluorescence in petrol. However, the Karanja oil itself gives a blue fluorescence in alcohol showing maximum at 470 m μ while yellowish green fluorescence in petrol with maximum fluorescence at 540 m μ (Fig. IV).

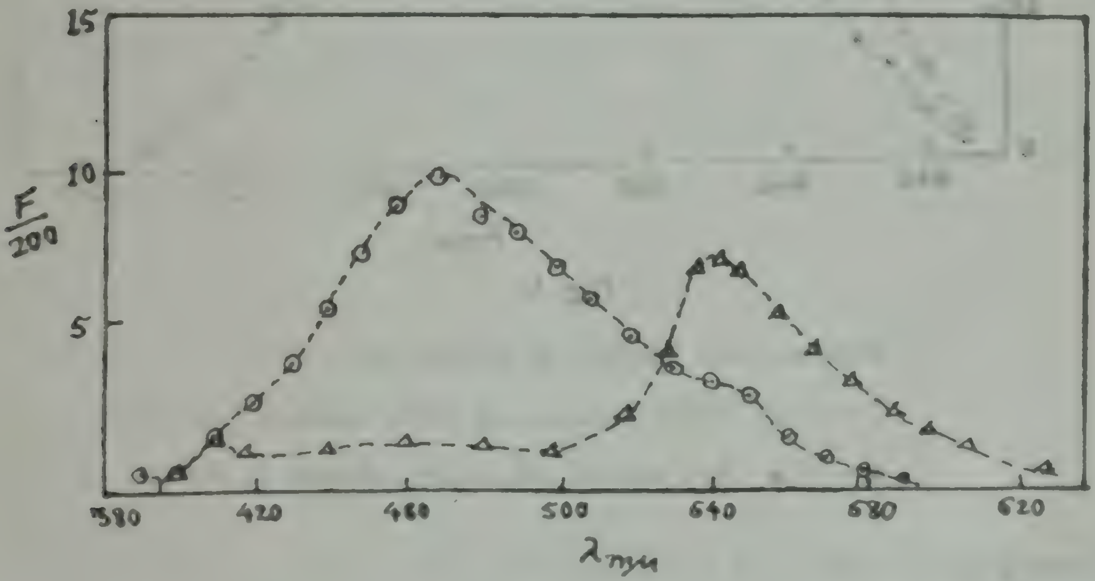

Fig. IV.

⊙ - - ⊙ Fluorescence spectra of Karanja oil.

△ - - △ 0.076 g/l of Karanja oil in alcohol.

0.096 g/l of Karanja oil in Petrol.

Fluorescence spectra of the two varieties of sesame oils were measured in petrol. At the low concentrations of the oils, soluble in alcohol, only a light whitish blue tone is shown. In petrol solution the red sesame oil gives a bluish-green fluorescence and a maximum at 521 m$\mu$ while the white sesame oil gives a greenish-blue fluorescence and a maximum at 505 m$\mu$ (Fig. V). The new compound (m.p. 120°C) gives a greenish-blue fluorescence in alcohol solution and shows a maximum at 470 m$\mu$.

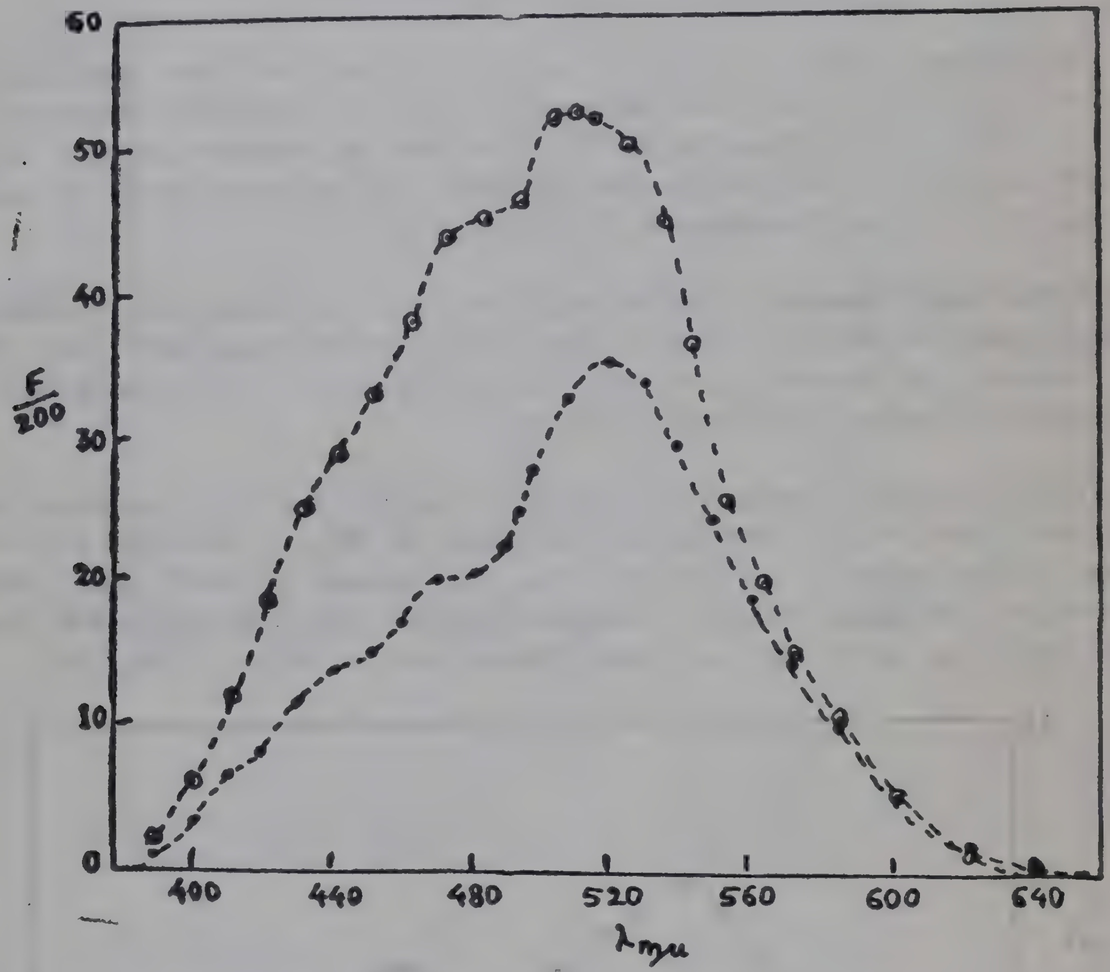

Fig. V.

**Fluorescence spectra of sesame oils.**

**⊙ - - ⊙ White sesame oil (46% solution in Petrol).**

**● - - ● Red sesame oil. (45% solution in Petrol).**

Spectgraphic analyses of the fluorescence of various vegetable oils have been carried out by H. Marcelet and H. Debono (13, 14) and by J. Guillot (15). The various data available, however, seem to be inconclusive as far as detection of adulteration is concerned. Jang B. Jha (16) has recently reported fluorescence measurements for the detection of adulteration of ghee by oils like sesame oil. From the measurements of the absorption and fluorescence spectra of karanja and sesame oils under present study it may be said that oils may be characterised by fluorescence more than by absorption, the fluorimeter used being highly sensitive.

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# COMPONENT FATTY ACIDS OF HYDROGENATED FATS

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**Two brands of hydrogenated fats were analysed for their component fatty acids by low temperature crystallization, alkali isomerisation, spectrophotometry and fractional distillation of methyl esters. Myristic acids amounted to about 0.1-0%. Stearic and palmitic acids constituted 8.7 to 10.0% and 8.5 to 8.7% respectively, Content of Behenic and arachidic acids was 6.9 to 8.8%. Iso-oleic and oleic acids from 71 to 74%. Linoleic acid amounted to 1.6 to 2.23%.**

Recently, Belekar et al (1) have shown that vanaspati samples varied considerably, in their properties and fatty acid glyceride composition. Magar (2) studied the component fatty acids of two hydrogenated fats. The present study incorporates the results of the component fatty acids of hydrogenated products of different brands processed in India.

**Experimental:**

The hydrogenated oils were saponified by the method of Hilditch (3) and the mixed fatty acids were crystalized at different low temperatures from ether and acetone (10 ml./g.) according to Gupta and Hilditch (4). Separation of fatty acids are given in Tables I and II. Linoleic and linolenic acids were estimated in the unsaturated fractions by alkali isomerisation and spectrophotometrically (5). Remaining fractions were methylated and the methyl esters were fractionated in an electrically heated packed column designed by Longenecker (6) under reduced pressure. Saponification equivalents (S.E.) and iodine values (I. V.) were determined by the A.O.C.S. official methods and the calculations were based on the recommendations of Hilditch (3).

**Results & Discussion :**

The component acids of fat No. 3 and 4 are shown in tables II & III respectively. Myristic acid content was 1.0% in fat No. 2. Hilditch and Riley (7) have shown the presence of myristic acid in Indian groundnut oils. Palmitic acid was varying from about 8.5 to 8.8%, stearic acids 8.7 to 10%. Arachidic and Behenic acids varied from 6.9 to 8.8%. Arachidic and Behenic acids were found to be from 5 to 6.6%, by Hilditch and Riley. (7) in Indian groundnut oils. Magar (2) had also shown 10 to 11% of these acids in two hydrogenated fats. In unsaturated group linoleic acids were predominently present (71 to 74%). The percentage of iso-oleic acids were not shown separately because it was shown by Jackson and Callen (8) that the results obtained by the lead salt alcohol separation were plus in error by about 20 to 40 per cent as compared with the infrared method.

## Acknowledgements :

The authors are thankful to the Vanaspati Manufacturers' Association for the supply of hydrogenated fat samples. Their thanks are due to the Council of Scientific & Industrial Research, New Delhi, for sponsoring the scheme. Their thanks are also due to Dr. J. G. Kane, Head, Oils and Fats Division, University Department of Chemical Technology, Bombay for his many helpful suggestions and keen interest.

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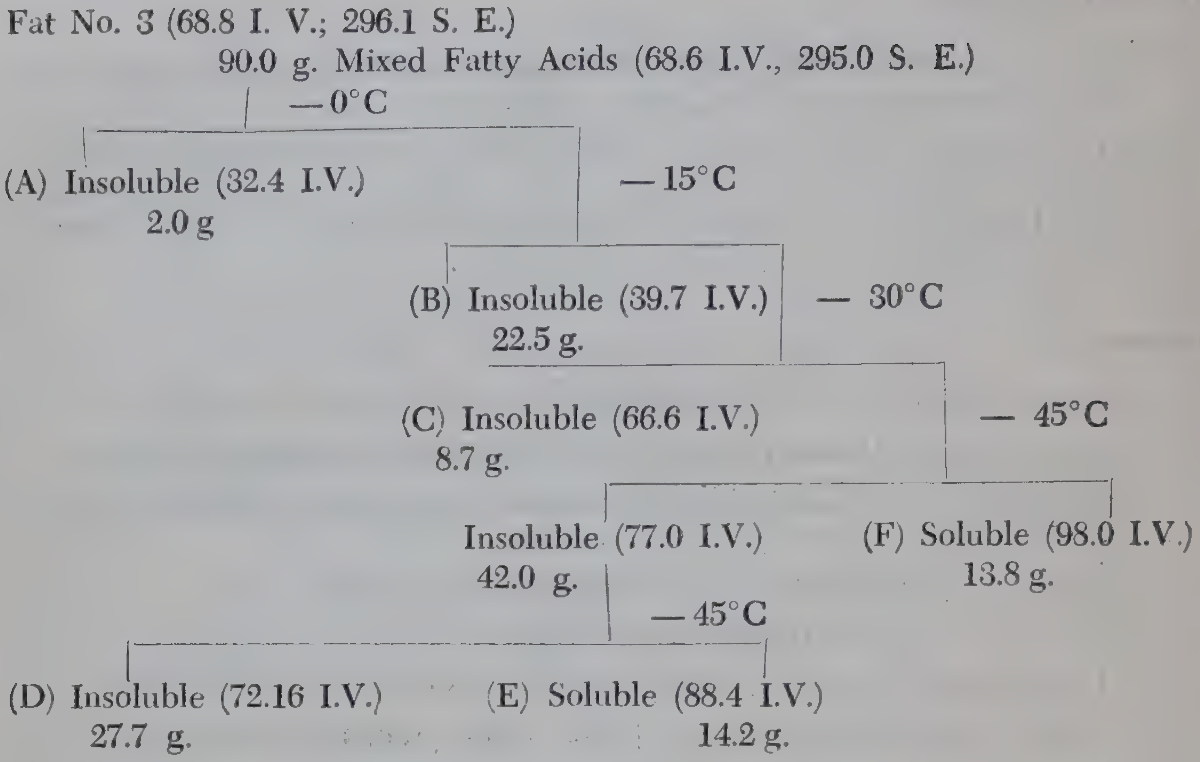
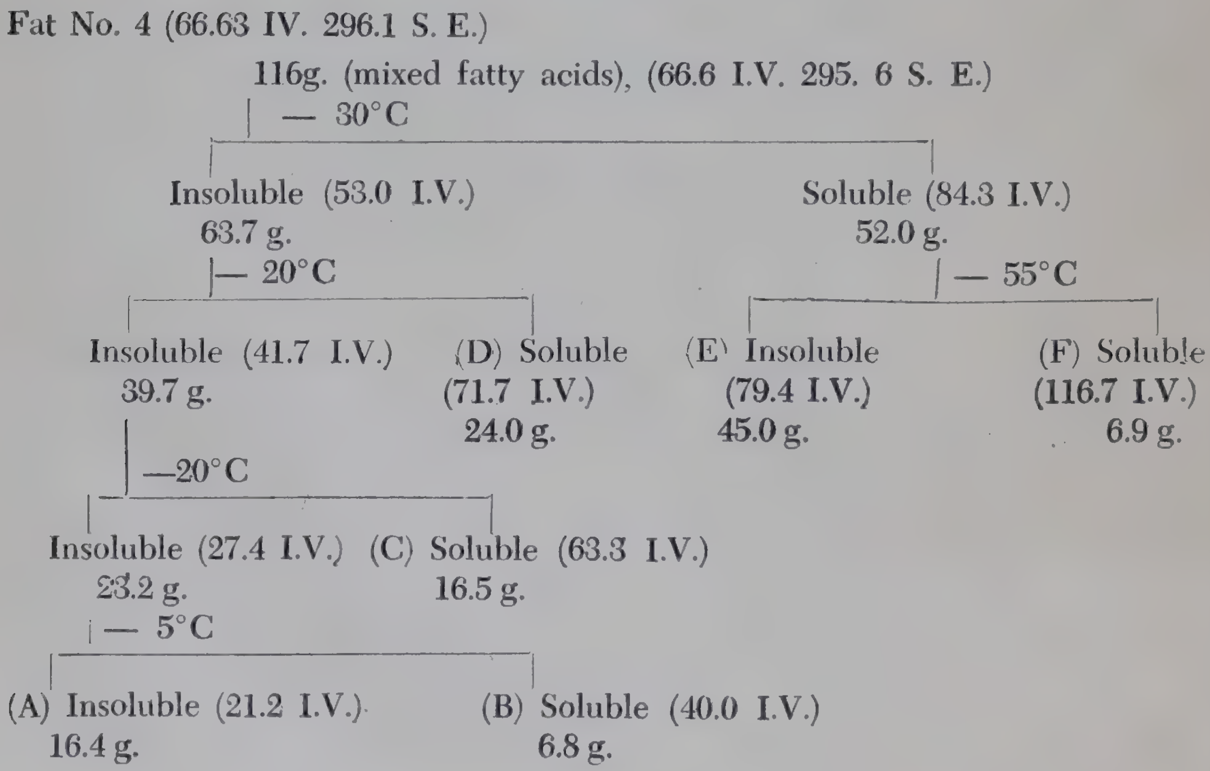
## TABLE I


Fat No. 3 (68.8 I. V.; 296.1 S. E.)
90.0 g. Mixed Fatty Acids (68.6 I.V., 295.0 S. E.)
— 0°C
(A) Insoluble (32.4 I.V.) 2.0 g
— 15°C
(B) Insoluble (39.7 I.V.) 22.5 g.
— 30°C
(C) Insoluble (66.6 I.V.) 8.7 g.
— 45°C
Insoluble (77.0 I.V.) 42.0 g.
(F) Soluble (98.0 I.V.) 13.8 g.
— 45°C
(D) Insoluble (72.16 I.V.) 27.7 g.
(E) Soluble (88.4 I.V.) 14.2 g.

## TABLE II


Fat No. 4 (66.63 IV. 296.1 S. E.)
116g. (mixed fatty acids), (66.6 I.V. 295. 6 S. E.)
— 30°C
Insoluble (53.0 I.V.) 63.7 g.
Soluble (84.3 I.V.) 52.0 g.
— 20°C
— 55°C
Insoluble (41.7 I.V.) 39.7 g.
(D) Soluble (71.7 I.V.) 24.0 g.
(E) Insoluble (79.4 I.V.) 45.0 g.
(F) Soluble (116.7 I.V.) 6.9 g.
—20°C
Insoluble (27.4 I.V.) 23.2 g.
(C) Soluble (63.3 I.V.) 16.5 g.
— 5°C
(A) Insoluble (21.2 I.V.) 16.4 g.
(B) Soluble (40.0 I.V.) 6.8 g.

## TABLE III.

### Component Acids in Fat No. 3

| ACIDS | Component acids of Fractions % | | | | | Total w/w | % Moles |
|---|---|---|---|---|---|---|---|
| | A | B | C+D | E | F | | |
| Palmitic | — | 3.28 | 3.24 | — | — | 6.52 | 7.20 |
| Stearic | 1.35 | 4.42 | 2.96 | — | — | 8.73 | 8.69 |
| Arachidic | — | 6.49 | 1.92 | 0.34 | — | 8.75 | 7.93 |
| Behenic | — | — | 0.09 | — | — | 0.09 | 0.07 |
| Unsaturated Fractions. | | | | | | | |
| C18 (—2H) | 0.90 | 11.17 | 32.73 | 15.36 | 14.12 | 74.28 | 74.47 |
| C18 (—4H) | — | — | — | 0.23 | 1.40 | 1.63 | 1.64 |
| Total | 2.25 | 25.36 | 40.94 | 15.93 | 15.52 | 100.00 | 100.00 |

## TABLE IV.

### Component acids in Fat No. 4.

| ACIDS | Component acids of Fractions % | | | | | | Total w/w | Moles % |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | | |
| Myristic | — | — | — | 0.50 | 0.53 | — | 1.03 | 1.27 |
| Palmitic | 0.82 | 1.91 | 1.38 | 2.10 | 2.36 | — | 8.57 | 9.42 |
| Stearic | 6.31 | 1.37 | 0.85 | 0.31 | 1.17 | — | 10.01 | 9.92 |
| Arachidic | 3.00 | — | — | 0.94 | 0.22 | — | 4.16 | 3.75 |
| Behenic | 1.00 | — | 0.33 | — | 1.39 | — | 2.72 | 2.25 |
| Unsaturated Fractions | | | | | | | | |
| C18 (—2H) | 3.08 | 2.59 | 11.71 | 16.89 | 32.75 | 4.26 | 71.28 | 71.15 |
| C18 (—4H) | — | — | — | — | 0.48 | 1.75 | 2.23 | 2.24 |
| Total | 14.21 | 5.87 | 14.27 | 20.74 | 38.90 | 6.01 | 100.00 | 100.00 |

# STUDIES ON KAVATHI OIL (HYDNOCARPUS WIGHTIANA, BLUME)

## PART I

## Hydrogenation of the oil

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**The course of hydrogenation of the oil was studied at 180°C with 3% Raney nickel catalyst by analysing periodical samples for their iodine values, refractive indices, optical rotations and melting points. It is interesting to note that the optical rotation of the oil is lost at an iodine value of about 68. It is suggested that the optical inactivity is produced by a shift of the double bond in the cyclopentenyl ring of the cyclic acid under the conditions of hydrogenation.**

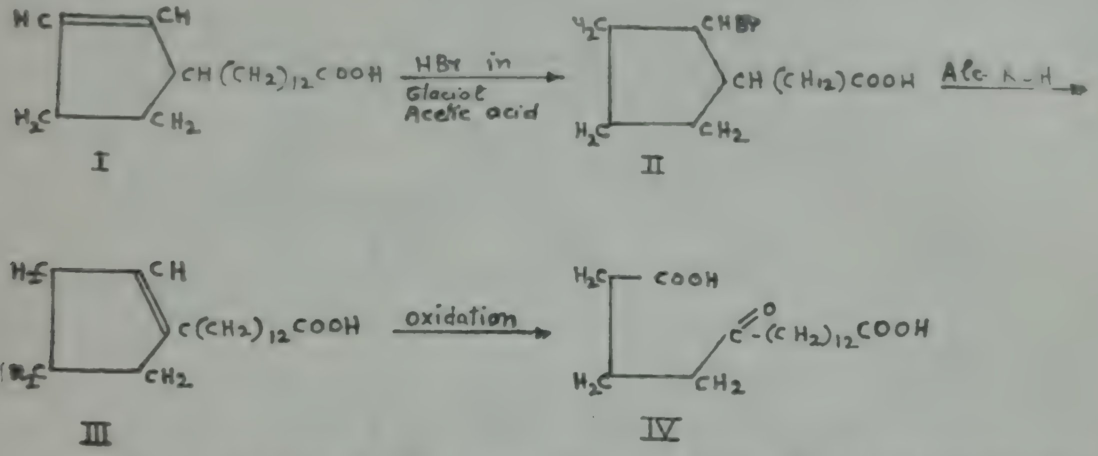
The trees of **Kavathi** called **Maroti** in South India grow along the Indian West coast belt down to Malabar. The seeds of the tree after decortication are pressed in ghanis which yield between 25 to 30 per cent of the oil. The oil is viscous, has a pale yellow colour and a sweetish odour.

The oil is not a commercial commodity but is said to be available in substantial quantities in villages. It is commonly used in oil lamps for lighting. It is also used for external application in skin diseases. In the Ayurvedic System of Medicine, it is prescribed for leprosy. It is occasionally used in soap manufacture.

The characteristic feature of this oil is its large content of cyclo-pentenyl acids, viz. hydnocarpic, chaulmoogric and gorlic acids which have an asymmetric carbon atom. The oil has thus a considerable optical activity. Joseph and Sudborough (1), hydrogenated a sample of maroti oil obtained from Cochin, at atmospheric pressure using 1 per cent dry reduced nickel catalyst at 180°C. The oil was completely reduced in about five hours but it lost its optical activity within 20 minutes of starting the hydrogenation, at an iodine value of 75. Joseph and Sudborough (1) assumed that the cyclic acids were reduced preferentially to oleic and linoleic acids and that the iodine value of 75 of the partially hydrogenated oil corresponded to complete saturation of the cyclic acids. The assumption that the oil contained both oleic and linoleic acids was not substantiated by the later extensive work Cole and Cardoso (2) who found only 6.5 per cent oleic acid and no linoleic acid in H. Wightiana oil. The presence of linoleic acid in this oil has also not been reported by the workers (3, 4). The absence of linoleic or other higher unsaturated acids in this oil has now been further confirmed by the absence of absorption in the ultra-violet region at 224 and 265 m $\mu$ (Expt. D).

The observation of Joseph and Sudborough (1) that the partially hydrogenated oil becomes optically inactive has been confirmed in the present work. The oil was hydrogenated at 180°C using 3 per cent Raney nickel as catalyst and within 3 hours when the oil attained an iodine value of 77-8, its optical rotation had dropped down to + 5.8° only (Table 2; Fig. 1). With further hydrogenation the oil became completely inactive. It is worth noting here the finding of

Shriner and Adams (5) that drastic treatment such as prolonged distillation or heating for 2 days at 250 C in a closed tube or heating with alkali did not racemize chaulmoogric acid (I). However, they were able to prepare inactive chaulmoogric acid which they termed "isochaulmoogric acid" (III) by the following reactions:—



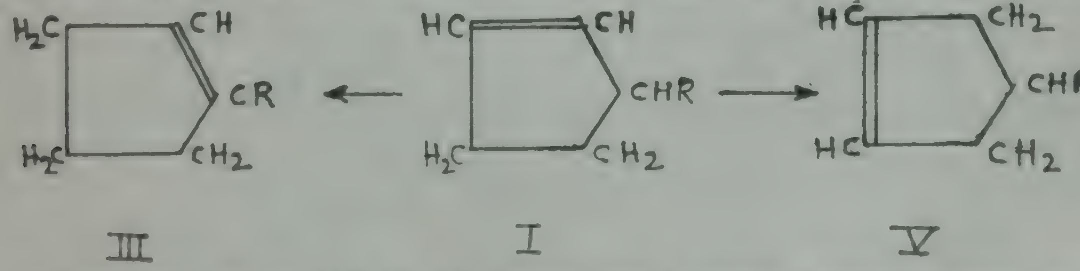
The structure of the inactive acid (III) was confirmed by its oxidation product (IV). Hinegardner (6) also prepared an optically inactive chaulmoogric acid from the natural acid by the following reactions—

d. chaulmoogric acid ⟶ d. amide

Distilled over $P_2O_5$ ⟶ Optically inactive nitride ⟶ (Hydrolysis) optically inactive acid

The mechanism of this recemization is not known, although Hinegardner (6) postulated the formation and subsequent breakdown of a weak additional product at the double bond by $P_2O_5$.

To the above two methods of racemization, may now be added a third method of partial hydrogenation. Merely heating the oil by itself to the temperature of hydrogenation or heating the oil with Raney nickel (3%) only (in absence of hydrogen) did not decrease the optical activity of the oil (Expts. E and F). It must, therefore, be concluded that it is only during hydrogenation itself that inactivation takes place. It is well known that oleic acid isomers are produced by a shift in its double bond during hydrogenation. It is, therefore, not unlikely that a similar shift in the double bond takes place in the cyclo-pentene ring of the chaulmoogric acid and its homologues as shown



Which isomer (whether III or V) is produced during hydrogenation can be known only after examining the products of oxidation of a partially hydrogenated ester of chaulmoogric acid.

The overall hydrogenation rate of the oil using Raney nickel is low since it has taken nearly 10 hours to bring its iodine value from 103 to about 1. This is in contrast to about 3 hours required in the experiments of Joseph and Sudborough (1) who used a dry reduced catalyst which must have been quite active. Raney nickel is, however, known to be not as active as the dry reduced catalyst.

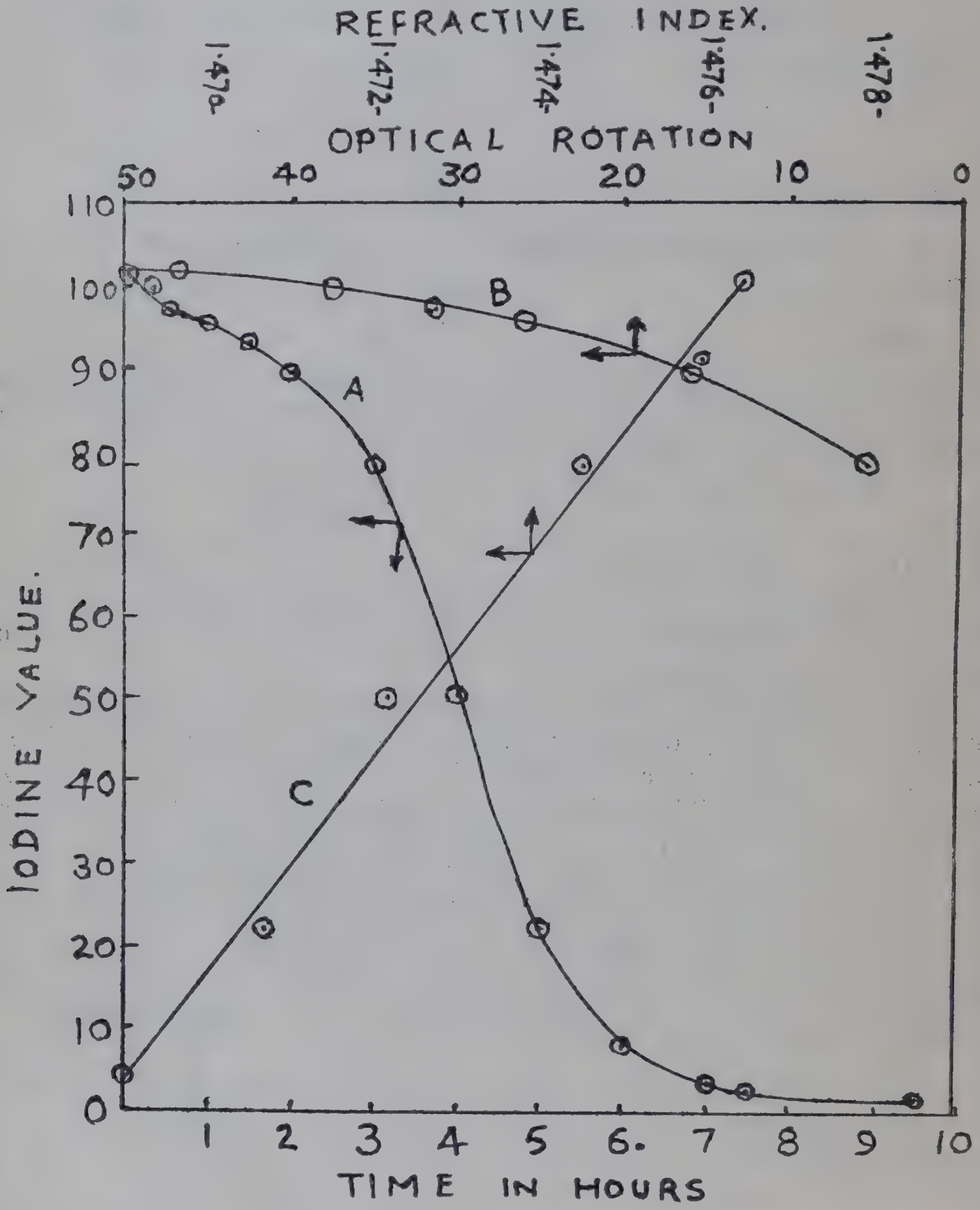


**Fig. I — Course of hydrogenation of Kavathi oil.**

Curve A — Reduction in iodine value with time of hydrogenation.

Curve B — Relation between iodine value and optical rotation.

Curve C — Relation between iodine value and refractive index.

The time — I. V. curve (Fig. 1) showing the course of hydrogenation is somewhat peculiar and falls in three parts. In the beginning the reaction is rather slow, requiring 2 hours for a drop of 10 units in the I. V. The next drop in I. V. from 90 to 10 has been very rapid taking only 4 hours while a further drop of about 9 units occurs over a period of 4 more hours.

The optical rotation — I. V. Curve (Fig. I) shows a very rapid disappearance of the rotation in the early stage of hydrogenation.

rather slow, requiring 2 hours for a drop of 10 units in the I. V. The next drop

The graph of I. V. — R. I. is a straight line (Fig. I).

The hydnocarpic and chaulmoogric acids melt at 60°C and 68.5°C respectively while the corresponding fully saturated acids (7) melt at 63°C and 71.5°C. In spite of these high melting points of these constituent acids, the fully hardened oil melts at about 31°C only, (Table 2). This is in contrast with other fully hardened oils like hardened cottonseed oil which melts at about 60°C.

**Experimental:**

(A) The raw Kavathi oil was obtained by pressing the crushed kernels in a laboratory hydraulic cage press at room temperature. (about 30°C). The yield of the cold drawn oil was 47%. The oil was refined by aqueous alkali. The analytical constants of the raw and refined oils are given in table I.

### TABLE I.

### Constants of Kavathi Oil

| | Raw oil | Refined oil |
|---|---|---|
| Acid value | 3.6 | 0.2 |
| Sap. value | 204.7 | 204.3 |
| Iod. value (Wijs) | 99.7 | 102.8 |
| R. I. (30°C) | 1.4772 | 1.4765 |
| Optical rotation (30°C) | 53.2 | 53.3 |

(B) Hydrogenation was carried out at 180°C using 3 per cent freshly prepared Raney nickel catalyst. A three-neck round bottom glass flask provided with a stirrer, a thermometer, inlet and outlet tubes for hydrogen and a sampling tube served as the reaction vessel. An electric heating mantle with a regulator maintained the required constant temperature. Samples taken out periodically were analysed for iodine value (Wijs), refractive index, melting point and optical rotation.

(C) Analytical constants of hydrogenated samples are given in table II and the various relationships between the constants are shown graphically in Fig. 1.

## TABLE II.

### Hydrogenation of Kavathi Oil.

Catalyst: 3% Raney nickel. Temperature: 180°C

| Sample No. | Time in hours | Iodine value | Ref. Index 32°C | Optical rotation 32°c D | Melting point °C |
|---|---|---|---|---|---|
| 1. | *0.0 | 100.6 | 1.4765 | + 46.85 | 12.5 |
| 2. | 0.25 | 99.2 | 1.4762 | + 37.36 | — |
| 3. | 0.5 | 96.9 | 1.4762 | + 31.10 | — |
| 4. | 1 | 95.1 | 1.4759 | + 25.60 | — |
| 5. | 1.5 | 93.1 | 1.4758 | + 25.60 | — |
| 6. | 2 | 89.1 | 1.4753 | + 16.10 | — |
| 7. | 3 | 77.8 | 1.4745 | + 5.80 | — |
| 8. | 4 | 50.2 | 1.4722 | Nil | — |
| 9. | 5 | 21.9 | 1.4707 | — | — |
| 10. | 6 | 8.1 | 1.4695 | — | — |
| 11. | 7 | 3.8 | 1.4691 | — | — |
| 12. | 7.5 | 2.3 | 1.4690 | — | 31.0 |
| 13. | 9.5 | 1.7 | 1.4690 | — | 31.2 |

* The O hour sample was taken when the temperature has reached 180°C.

(D) The mixed fatty acids of the Kavathi oil were isomerized in the ethylene glycol reagent according to the procedure of Hilditch, Morton and Riley (8). Absorption was measured by means of a Beckman Spectrophotometer at the wave lengths of 234 and 265 m $\mu$. There was no absorption.

(E) The Kavathi oil was heated at 185°C at 10 mm. pressure for 4 hours. There was reduction in the optical activity of the oil.

(F) The Kavathi oil was heated at 185°C at 10 mm. pressure in contact with 3% Raney nickel catalyst for 4 hours. There was no reduction in the optical activity of the oil.

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# SOAPS
# &
# DETERGENTS

# USE OF NON-EDIBLE OILS IN SOAP MAKING

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**With the idea of replacing edible oils in the Soap manufacture, experiments have been conducted using non edible oils like neem, karanjia & undi oils in soap-making. Soaps so prepared have been found to compare well with the good quality washing soaps available in the market.**

The acute shortage of edible oils for human consuption makes it imperative that special efforts be launched to improve the situation and supplement the dinner table of the common man with a large quota of fat. And here the soap maker has an important role to play by introducing non-edible oils into soap industry and by sparing for human consumption at least a part of the edible oils he is at present consuming for his industry.

A detailed survey about the availability of the non-edible oil seeds has not yet been carried out. The Bombay State Forest Department has supplied the following figures for the annual production of neem and karanja:

| | | |
|---|---|---|
| Neem Seeds | 7,778 | Bengali maunds. |
| Karanja Seeds | 3,395 | ,, ,, |

Experiments were undertaken in this laboratory to utilise the most common non-edible oils like neem (Azadirachta Indica), karanja (Pongamia Glabra) and undi (Callophyllum Inophyllum) in making washing soaps, and these are described in this article.

One-third of the total charge of oils for soap-making has been replaced by one of the above oils and the soaps so prepared have been shown to be comparable with '501' bar soap, which is taken as a good quality soap, as regards their chemical analysis, lather value and detergency.

## Experimental :

The most important defects with the non-edible oils are their strong and disagreeable odour and colour and these can be overcome either by masking them or removing them by some method. Though the former method also has been successfully tried in this laboratory, it is found that the later would be the better one and has therefore been adopted.

For removing the odour, graining of the soap is resorted to. However, instead of graining the whole soap stock which is unnecessary, uneconomic and inconvenient for a small scale soap maker the soap from the non-edible oil was prepared in the first instance and grained as follows:-

The oil is saponified by the required quantity of caustic soda. The Soap so formed is then melted and grained in two stages, first with common salt (about 10% of the total volume) and then with caustic soda (about 8° Be solution). The yield of the soap was about 1½ times the weight of the oil.

The grained soap was then used along with other oils like coconut, groundnut etc. in the following formula.

| | | |
|---|---|---|
| Coconut oil | 48 parts | |
| Grained soap of non-edible oil | 50 ,, | (Corresponding to 33⅓% of oil). |
| Groundnut oil | 8 ,, | |
| Castor oil | 4 ,, | |
| Rosin | 7 ,, | |
| | 100 parts | |

The soap was prepared by the semi boiled process, the addition of grained soap being made in form of thin flakes which introduced no difficulty in the process. The addition of colour (metanil yellow) is optional.

The following table gives the analyses of the soaps thus prepared and of a sample of '501' bar soap from the market.

## TABLE No. 1

| S. No. | Sample | Fatty acids | Moisture | Free Alkali | Total Alkali | Odour |
|---|---|---|---|---|---|---|
| 1. | 501 bar soap | 67.30 | 22.50 | 0.08 | 9.60 | Perfume odour |
| | Neem soap | 69.30 | 23.03 | — | 8.20 | Slight rosin smell |
| 3. | Undi soap | 66.50 | 23.83 | 0.1 | 7.88 | -do- |
| 4. | Karanja Soap | 64.90 | 25.70 | 0.3 | 7.48 | -do- |

In order to throw further light on the quality of the soap the determination of the lather value and detergency tests were carried out by the methods used by Gupta, Phadnis and Aggarwal (1). The results are given in the following table.

## TABLE No. 2 (Lather value)

| Sample | After 5 minuts | After 1 hour | After 24 hours | Remarks |
|---|---|---|---|---|
| 501 Soap | 260 cc. | 260 cc. | 260 cc. | Thinned (thinner than neem and undi) |
| Neem Soap | 260 cc. | 260 cc. | 260 cc. | Thinned. |
| Undi soap | 275 cc. | 270 cc. | 260 cc. | Thinned. |
| Karanja soap | 255 cc. | 255 c.c. | 250 cc. | Thinned (Comparable with 501 bar soap) |

The thinning of soap lather may be attributed to the difference in the major solid fatty acids in the three oils. The percentage content of stearic and palmitic acids of the three fats are given below (2).

|  | Stearic | Palmitic |
|---|---|---|
| Neem | 19.1 | 13.6 |
| Undi | 11.0 | 14.1 |
| Karanja | 2.2 | 6.6 |

The detergent quality of all the samples was found to be almost identical. The appearance of the samples was quite agreeable. Storage properties of the soaps were observed by keeping the samples in a wire gauge cupboard for a period of six months. It was found that the samples kept well.

**Economics :**

It was found that by making use of the above procedure of utilising grained non-edible oil soap (on a small scale) the overall cost of the final product is raised by about one pice (three pies) per lb. of soap which is not very high considering the benefits secured therefrom.

**Details of expenditure for graining non-edible oil soap prepared from 10 lbs. of oil.**

| | | |
|---|---|---|
| 1. | Quantity of oil ... ... ... ... | 10 lbs. |
| 2. | Quantity of caustic soda for saponification | 4 lbs. of 30° Be solution. |

(This quantity is not taken into account for purposes of calculation of the cost of graining since there will be a saving of an equal amount of caustic soda when preparing the final soap. In the final soap the cost of caustic soda required for the whole lot including the non-edible oil part is taken into account.)

| | | | |
|---|---|---|---|
| 3. | Quantity of sodium chloride 10% on the total volume — 2 lbs. for a total volume of 10 lbs. | | 0- 1- 0 |
| 4. | Quantity of caustic soda for second graining (8.10%) ... ... ... ... | 1 lb. | 0- 6- 0 |
| 5. | Fuel required ... ... ... ... | 4 lbs. | 0- 4- 0 |
| | | Total : | 0-11- 0 |

The cost of the oil is raised by about one anna per pound if grained soap is used in the place of the oil. If calculated on the basis of 100 lbs. of oil, the cost per lb. of the final soap will be increased by one pice.

**Conclusion :**

It can, therefore, be concluded that by graining the non-edible oil soap along with other oils, we can have washing soaps of agreeable odour and colour. The alternate method of masking the disagreeable odour and colour of the non-edible oil soaps by use of perfume and colour will not be as economical as this.

**References :**

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# SULPHATION OF FATTY ACIDS

**T. N. Mehta and B. Y. Rao.**

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**The action of sulphuric acid at double bond and hydroxyl group has been discussed with the possible formation of sulphates, sulphonates and hydrolysed products. The sulphation of oleic acid with suphuric acid is discussed in detail. The effect of time, concentration of sulphuric acid, molar ratio of sulphuric acid to oleic acid and temperature on the degree of sulphation and the extent of hydrolysis has been studied. Maximum sulphation of about 82% to 83% has been obtained with 1:3.5 molar ratio of oleic acid to 36N sulphuric acid. From the industrial point of view, the fundamental knowledge of rates of sulphation of castor oil and its fatty acids, oleic acid and oleyl alcohol has been recorded. The reaction of sulphuric acid of concentrations ranging from 70.8% to 12% oleum at 90° C on oleic acid showed that the maximum amount of sulphates are obtained with 85% to 89% sulphuric acid. Sulphuric acid of strength below 85% gave only hydrolysis and that above 89% gave sulphonates along with the sulphates. Possibility of dehydration of hydroxy-acids formed during sulphation has been indicated. (29 reference).**

Sulphated oils which were the earliest modifications on soaps, were produced early in the nineteenth century. They were used as emulsifying and wetting agents, and assistants in textile processing as in scouring, bleaching, dyeing and finishing; a role which is still very important today. Sulphonated castor oil is used for introducing fatty matter in leather to make it soft and pliable. Paint industry employs sulphated oils as wetting agents for pigments in the grinding operation and also in the manufacture of emulsion paints. Mixtures of sulphated and sulphonated oils act as defoamers in the paper industry. Some cutting oils for metal industries are highly sulphated sperm or cod oils. Large amounts of sulphonated castor oil and their derivatives are used in breaking emulsions in crude oil to separate oil and water fractions. Sulphation of fatty acids is also used for producing hydroxy acids and trans-solid acids. Fatty alcohols of coconut and palmkernel oils, after treatment with sulphuric acid or sulphur trioxide, form anionic detergents which are used for washing woollens and fine fabrics, on account of their ready solubility and excellent foaming power.

Fremy (1) first sulphonated olive and almond oils and Runge (2) neutralised them and found the product most satisfactory as a mordent in dyeing calico red. Since then several dyers started the preparation of sulphated castor oil which was called "Turkey Red Oil". Procter (3) first introduced sulphated product in leather industry for fat liquoring of leather. Later on "Monopol Soaps" were prepared by sulphating castor oil and neutralizing it with excess of alkali and heating to gelation. Now-a-days, large number of vegetable, animal and fish oils or their fatty acids and alcohols are subjected to the action of concentrated sulphuric acid. oleum, chlorosulphonic acid, sulphurtrioxide complexes with pyridine and acetyl sulphuric acid. These normal sulphating agents are combined with the use of solvents such as acetic anhydride, glacial acetic acid and pyridine. The undesirable side reactions and charring due to exothermic process necessitate the use of solvents to effect the reactions under as mild conditions as possible. After completion of reaction, the product is washed with 10% to 20% cooled brine or sodium sulphate solution to remove unreacted sulphuric acid. It is then neutralised to the desired pH with caustic soda or potash and/or ammonia. The stability and size of the emulsions depend on the pH value of the sulphated product. The sulphate and sulphonate groups are neutralized at pH 4 and the —COOH group which reduces the stability to hard water, is neutralised at about pH 9.

The treatment of fatty acids or oils with sulphuric acid renders them soluble or miscible with water depending on the type of oils used and degree of sulphation and sulphonation. The sulphates are those in which -$SO_3H$ group is linked to the carbon atom of the fatty acid chain through oxygen such as R-O.$SO_3H$; while the sulphonates have direct carbon to sulphur linkage of the form R-$SO_3H$. The most important difference in the behaviour of sulphates and sulphonates is that the former are not stable to boiling mineral acids, and magnesium and calcium salts; whilst the latter are stable under these conditions. Usually, sulphated oils or acids are evaluated by their $SO_3$ content. Oils containing 1-3% of $SO_3$ give good emulsions and those with 4% give transparent solutions. Most of the sulphated oils usually, contain 3 to 5% of $SO_3$. The properties of these products depend on the surface active groups -$SO_3H$ or -$OSO_3H$, their position and the chain length of fatty acids. The alkali metal salts of -$OSO_3H$ groups are regarded as emulsifiers and those of -$SO_3H$ groups as wetting agents. The sulphate group at the end of the chain gives foaming and detergent properties to the products, while the surface active group in the middle of the chain gives emulsifying and wetting properties.

It is generally agreed that sulphuric acid has no action on saturated fatty acids since they do not contain any double bond; but it does react with saturated hydroxy acids and can decompose them under certain conditions. During sulphation of oleic acid with sulphuric acid. Muller (4) and Liechti and Suida (5) assumed the evolution of sulphur dioxide along with the formation of oxy-acids. Saytseff (6) and Geitel (7) independently, observed hydroxy stearic acid in the reaction products. Bendikt and Ulzer (8) found the formation of sulphuric-ester and hydroxy acid along with its anhydrides. Lewkowitsch (9) then studied the sulphation of oleic acid with concentrated sulphuric acid and found that the iodine value of the product could not be reduced to zero. He used for the reaction sulphuric acid of concentrations varying from 92% to

103%. It was found that the maximum amount of saturated products was not obtainable with 100 or more per cent of $H_2SO_4$. Hydroxy-Stearic acid with a considerable conversion of oleic acid to iso-oleic acid was obtained. At 132°C the reaction of sulphuric acid with oleic acid indicated an increased proportion of stearo-lactone. Shukoff (10) patented the direct production of stearo-lactone by treating oleic acid with the theoretical amount of concentrated sulphuric acid at 70° to 80°C and Clutterbuck (11) published the details of the method of its isolation.

Riess (12) investigated the influence of time, temperature and amount of acid in the sulphonation of oleic acid. As the proportion of sulphuric acid used on the weight of oleic acid was increased from 20% to 40% the maximum $SO_3$ content was obtained with 37.5% of $H_2SO_4$, after which it decreased. The reaction was mainly at the double. The rise in temperature of reaction from 0° to 20°C decreased the $SO_3$ content. The sulphuric ester formed was rapidly hydrolysed to hydroxy stearic acid which in turn gave condensed products. He obtained 63.4% of suphonated oleic acid without the formation of oxy-acids during five hours with 40% sulphuric acid on the weight of oleic acid. In the case of oleyl alcohol the increasing proportion gave rise in sulphate formation, the addition being at both the double bond and hydroxyl group. The increase in temperature reduced the time of sulphation. Maximum sulphation (80.6%) occurred at 0°C whilst there was 76.2% sulphation at 30°C. The esterification was maximum at 40°C in 5 hours, and then with higher temperature decreased due to hydrolysis. Riess, in his later communication (13), showed that certain proportion of oleic acid was converted into iso-oleic when 20% to 40% sulphuric acid on the weight of oleic acid was used.

In Turkey red oil, presence of mono or di-sulphuric esters and di-and poly-ricinoleic acids was observed along with the splitting of glyceride molecules. The important contribution was made by Grun and Woldenberg (14) showing that sulphuric acid reacted at 0°C primarily at the hydroxyl group and secondarily at the double bond in the case of castor oil. Nishizawa and his collaborators (15, 16, 17) made a valuable series of researches and found that the action of sulphuric acid on ricinoleic acid in cold was as follows :—

$$\begin{aligned}CH_3\,(CH_2)_5CHOH\;CH_2CH = CH\;(CH_2)_7COOH + H_2SO_4 &=\\ CH_3(CH_2)_5CH(OSO_2OH)CH_2CH = CH\;(CH_2)_7COOH.&\end{aligned}$$

They obtained sodium-sulpho-ricinoleic acid in pure form in presence of ether under controlled conditions. The action was almost at the hydroxyl group in presence of solvents.

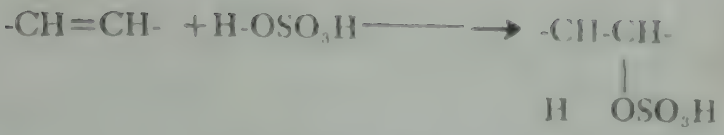
Burton and Robertshaw (18) observed hydrolysis of castor oil during sulphation and found that at 50°C sulphonates were formed. The reaction was not a simple case of esterification as there was a fall in iodine value. Burton and Byrne (19) in their series of articles on constitution of sulphated oils revised the analytical methods which were used to interpret the reactions. They have studied the reaction of castor oil, ricinoleic and oleic acids with 98.8 sulphuric acid in different proportions and also with chlorsulphonic acid presence of glacial acetic acid. With both the reagents, they have shown t possibilities of formation of hydroxy sulphonates of ricinoleic acid at 50°C. case of castor oil, hydrolysis of triglycerides was considerable, and the ma reaction was at the -OH group whereas acetylated castor oil gave reaction the double bond. The largest amounts of hydroxy acids were observed wh 37.5% of $H_2SO_4$ on the weight of oleic acid was used for sulphation at 20° while at 50°C more of lactones, lactides and estolides were obtained. Ro Schaeffer, Dixion and Ault (20) studied the effect of temperature, time and mol ratio of sulphuric acid to oleic acid for the formation of hydroxy acids. Th concluded that 1:3 molar ratio of oleic acid to sulphuric acid gave almo complete reaction.

Regarding the sulphation of linoleic and linolenic acids very little wo has been published. Oleic and ricinoleic acids give homogeneous sulphat products, while acids containing two or more double bonds do not form wate miscible products. Twitchell (21) found that linoleic acid dissolved readily concentrated sulphuric acid. Staisny and Riess (22) sulphated the fish a neatsfoot oils containing 3 to 5 double bonds and showed that the highly u saturated acids were attacked first. Schindler and Schalher (23) made a ve comprehensive investigation of the use of sulphated neatsfoot and cod oils fat liquoring of leather. A fractionation technique with various solvents w used by them to study the constitution of sulphated oils. Reaction of linole acid with sulphuric acid gives a low yield of dihydroxy stearic acid of unknow structure and some mono-hydroxy oleic acid (by the addition of sulphuric ac to only one of the double bonds) as well as, oxygen-linked polymers (20).

Contrary to numerous investigations, Sericano (24) found that the decrea in the iodine number was roughly proportional to the amount of sulphuric ac used and the time of reaction. The acid number was some times decrease by sulphonation and this was explained as due to the formation of lactones internal anhydrides.

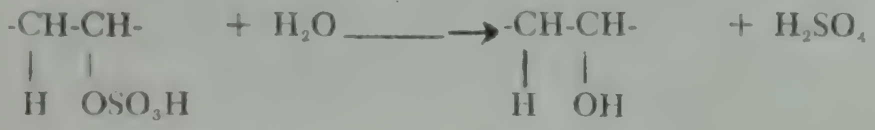
With a view to provide data on sulphation of fatty acids with sulphur acid and other sulphating reagents for industrial use, the fundamental wo on the rates and extent of reaction was undertaken in this laboratory. Sulph tion of oleic and ricinoleic acids, castor oil fatty acids and other higher fatt acids was selected because the use of simpler compound considerably eases th task of the analyst in this field and also the uniformity of raw materials simpl fies the process. Even under these circumstances the subject is one of unusu complexity. Oleic acid was taken for the study as a representative of mono thenoids, because of its wide occurrence in almost all vegetable oils.

The main initial reaction during sulphation at the double bond is a simp case of addition, without elimination of water. The generally accepte mechanism is :—



$$\text{-CH=CH-} + \text{H-OSO}_3\text{H} \longrightarrow \underset{\text{H}}{\text{-CH}}\text{-}\underset{\text{OSO}_3\text{H}}{\text{CH-}}$$

This reaction can be followed by estimating the fall in iodine value. It shows the extent of reaction at the double bond but not the degree of sulphation, as the sulpho-acids are easily hydrolysed under acid conditions to form hydroxy acids.



$$\underset{\text{H}}{\text{-CH}}\text{-}\underset{\text{OSO}_3\text{H}}{\text{CH-}} + \text{H}_2\text{O} \longrightarrow \underset{\text{H}}{\text{-CH}}\text{-}\underset{\text{OH}}{\text{CH-}} + \text{H}_2\text{SO}_4$$

These hydroxy acids are liable to get condensed to form lactones, lactides and estolides. Hence the iodine value is always lower than what the degree of sulphation would justify (25). The formation of iso-oleic acids observed by Lewkowitsch (9), Riess (13), and Steger and van Loon (26), increases the complexity of reactions. The course of reaction can also be followed by estimating the fall in acid value. One of the hydrogen atoms of the bivalent sulphuric acid is added to one carbon atom at the double bond and -OSO$_3$H to the other. Thus, on the addition of one mole of sulphuric acid, its acidity is lowered to half.

The extent of sulphation of oleic acid in carbon tetrachloride medium was investigated in this laboratory by studying the effect of time, concentration of sulphuric acid and molar ratio of oleic acid to sulphuric acid (Part I) (27). The degree of sulphation was determined by the fall in acidity and the extent of reaction at the double bond by the fall in iodine value. Data indicated that some of the acid remained unattacked by sulphuric acid and that such changes as shifting of double bond might be taking place. Because the sulphate group was hydrolysed, the amount of sulphuric acid absorbed by oleic acid calculated from the fall in iodine value was more than that calculated from decrease of acid value. The iodine value was not affected by further hydrolysis, whereas the acid value increased owing to the liberated sulphuric acid. The difference in sulphuric acid absorbed, calculated from the fall in iodine and acid values indicated the extent of hydrolysis of sulphated oleic acid. Sulphation of oleic acid was increased with the use of higher concentration and large ratios of sulphuric acid. Maximum sulphation of about 82% to 83% was obtained with 1:3.5 molar ratio of oleic acid to 36N sulphuric acid.

From the industrial point of view, the fundamental knowledge of rates of sulphation of castor oil and its fatty acids, oleic acid and oleyl alcohol have been recorded by us (Part II) (28). Each of them was treated with concentrated sulphuric acid in equimolar proportion at 0° C for half an hour and then the reaction mixture was brought to 28°-29° C. The iodine and acid values were determined at certain intervals. From the fall in these values the extent of hydrolysis of sulphuric esters formed and the amounts of sulphuric acid reacted at both (a) the double bond and (b) the OH group can be calculated. Oleyl alcohol and oleic acid react readily and the main reaction was at the double bond whereas in case of castor oil fatty acids it was at the -OH group. In case of castor oil considerable hydrolysis of glycerides was observed.

The experiments have also been carried out at 90°C to study the effect of concentration of sulphuric acid on the sulphation of oleic acid (Part III) (29). Sulphuric acid of concentration ranging from 70.8% to 12% oleum in the proportion of 1 : 3 moles was used. The products were washed free from sulphuric acid and analysed for total sulphate (-$SO_3H$ + -$OSO_3H$), sulphates (-$OSO_3H$), iodine balue and acid value. From these data the degree of hydrolysis and the extent of formation of hydroxy acids and their derivatives were calculated. Iodine values were decreased to a minimum when 85.5% sulphuric acid was used and then increased with the strength of sulphuric acid. Sulphates (-$OSO_3H$) formed at the double bond are hydrolysed to hydroxy acids which undergo dehydration in presence of strong sulphuric acid, thereby reforming the double bond. The reaction products prepared with sulphuric acid below 85.5% strength showed hydrolysis without formation of sulphates and sulphonates. The maximum amounts of sulphates were observed when 85.5% to 89.5% sulphuric acid was used. Sulphonates were formed besides sulphates by treatment with 98.8% sulphuric acid and 12% oleum and their formation may be due to the reaction at the -$CH_2$- group adjoining the double bond. The mechanism of reaction of sulphuric acid at different functional groups of fatty acids requires systematic study for obtaining specific products used in various industries.

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# SURFACE COATINGS

# SOME RAPID DRYING OILS OF INDIA

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**Oils obtained from seeds of chachinda, palwal, karela, kamala and sterculia foetida polymerise quite rapidly and may be satisfactorily used in paints and varnishes even as a substitute of tung oil in certain cases.**

Most widely used coating compositions are still based on the use of drying oils in combination with resins. Although linseed oil is the drying oil mostly employed in the preparation of paints and varnishes, tung and oiticica oils have gained importance in preparation of special types of coating materials. Tung oil has gained tremendous importance in the paints and varnish industry as it dries in 1/3rd the time which linseed oil requires and has other valuable properties like excellent resistance to water, sunlight, acids, alkalies and greases. It is extensively employed in the manufacture of electrical insulating varnishes capable of withstanding high tension currents, and for treating aeroplane fabrics. The oil is much used in paints required for automobile industry. Harvey and Collaborators (1) have taken a patent on a rubber substitute from tung oil which they claim to be superior to natural rubber in certain respects and is finding wide use as substitute for natural rubber in the U.S.A., in paints and varnishes and as a coating for textile fibres. It can be vulcanised like natural rubber and contains no free sulphur which is considered objectionable for certain purposes. These high qualities of tung oil have been attributed to elaeostearic acid which is a major component of the oil.

A need was felt for a systematic chemical examination of the lesser known oilseeds. The work carried out in this direction is summarised below:—

**Trichosanthes, anguina (2) Linn.** (English: Snakegourd. Hindi. chachinda) belonging to the natural order **Cucurbitaceae** is extensively cultivated in India as a vegetable crop. Its seeds contain about 32% oil which when exposed to air polymerises to a gel in two days. When applied on a glass plate with suitable driers, it dries to a non-tacky and flexible film in about an hour. The chemical examination of the oil showed that it contains about 40% trichosanic acid which is an isomer of elaeostearic acid present in tung oil.

The seeds of **Trichosanthes dioica** (3) Roxb (Hindi: Parwar or Palwal) belonging to the natural order **Cucurbitaceae** has also been found to contain about 28% of this triene conjugated acid and the film of the oil dries to a wrinkle surface very similar to tung oil film.

Another oil which has been found to behave very similar to tung oil is obtained from the seeds of **Momordica charantia Linn.** (Hindi: Karela) belonging to the same Natural order. Airan and Shah (4) reported the fatty acid composition of the oil as stearic and oleic acids. In a subsequent communication (5) Airan mentioned quick polymerisation and gelation tendencies of the oil even under ambient conditions and later on detected linoleic acid in it. Aggarwal (5), however, suspected the presence of polyethenoid conjugated fatty acids which were responsible for the rapid gelation of the oil. Further work using low temperature fractional crystalisation and ultra violet absorption spectro photometry showed that elaeostearic acid in karela seed oil (Bombay variety) was present to the extent of about 46%. Similar results have been recently reported by Chowdhary et al (7) in the oil from karelaseeds grown in Bengal.

At present snake gourd, palwal and karela seeds are collected for the cultivation of crops for vegetable purposes only and the whole fruits along with the seeds when unripe are consumed in the raw state mostly as vegetable. However, with the growing industrialisation of the country and development of the paints and varnish industry, the demand for rapid drying oils is bound to increase. On account of uncertainty in the position of supply of tung oil, it may be possible to have large scale cultivation of this climber for the seeds only. Further, as these crops are generally grown in the rainy seasons they are less costly.

All the seed oils described above contain elaeostearic acid or its isomer which is also present in tung oil, although in much larger amounts. As tung oil is generally used in paints and varnishes in conjunction with drying oils like linseed, the amount of the above oils can be adjusted in various compositions according to the quantity of this acid present in them.

There are, however, other vegetable oils, which dry even much more rapidly than tung oil and in which this property is due to the presence of other important and newly discovered conjugated double bond or pseudoconjugated fatty acids. Two of them on which research work has recently been undertaken at the National Chemical Laboratory are **Kamala oil** and **jangali badam oil**.

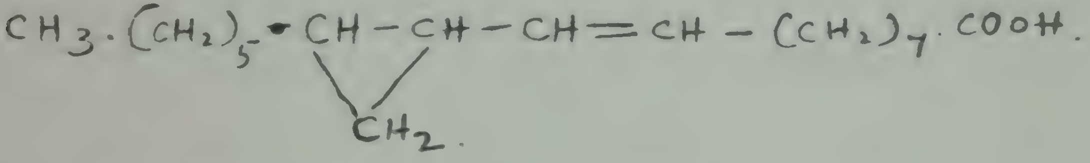
Kamala, Kamila, or Rohini botanically known as **Mallotus philippinensis Muell. Arg**, belongs to the **Natural Order of Euphorbiaceae.** It is a small ever green tree found throughout tropical India along the foot of the Himalayas from Kashmir eastwards upto 5000 ft. all over the Punjab, U. P., Bengal, Assam and from Sind Southwards to Bombay. It has been established that Kamala oil contains from 57 to 65% of 18-hydroxy—9: 11: 13 octadecatrienoic acid.

$$OH.(CH_2).(CH_2)_3.(HC=CH)_3.(CH_2)_7.COOH.$$

named kamlolenic acid. This finding has recently been confirmed by Calderwood and Gunstone (9) and Crombie and Taylor (10).

On account of the fact that a hydroxy carboxylic acid, kamlolenic acid is the major constituent fatty acid of the oil the entire quantity cannot be extracted with petroleum solvents. In this property kamala oil behaves very similar to castor oil. The other reason of this insolubility may be that a major portion of kamlolenic acid is not present as a simple glyceride in the oil but exists in a polyester condensed form. Ethyl ether, ethyl acetate or benzene extracts the entire quantity of the oil from the seeds. Experiments on efficient expression of the oil in a ghani, expeller or hydraulic press have not resulted in much success. The petroleum ether-extracted oil behaves very similar to tung oil in various coating compositions. The benzene-extracted oil, however, polymerises much more rapidly, its Brown heat test value being about 2 min. and 30 seconds. Work is in progress to control the high gelling tendency of Kamala oil so that this property of the oil may be used with advantage in the preparation of various coating compositions.

**Sterculia foetida Linn.** known as Java olive in English and Jangali Badam in Hindi is a large ever green tree found mostly in western and Southern parts of India. The seed kernels contain about 55% of pale yellow oil which undergoes rapid polymerisation at 240°-250° with evolution of heat and turns into an india rubber-like mass. This property of the oil has been attributed to the presence of an unique fatty acid called sterculic acid in the oil. Recent work (11, 13) has shown it to be a $C_{18}$ acid containing a cyclo-propane ring in conjugation with a double bond:



The oil on account of its quick polymerising tendency at room temperature and somewhat even at lower temperatures may form a valuable raw material for the paints and varnish industry. Preliminary work in this direction has shown that a film of oil when baked at 110-130° for 1 to 1½ hrs. sets to a smooth hard surface and thus the oil shows great promise of being used in baking enamels. Work is also in progress for the preparation of a rubber substitute from this oil and in the utilization of this oil in various coating compositions.

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# DRYING OIL FROM THE SEEDS OF STERCULIA FOETIDA (JANGALI BADAM)

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**The seed kernel of sterculia foetida, commonly known as 'Jangli Badam', contains about 54% of a pale yellow oil. It polymerises slowly at ordinary temperature but at 240-245° it gelatinises with spontaneous generation of heat into a rubber-like product.**

**The oil contains a unique fatty acid to the extent of over 70% which has been isolated by low temperature fractional crystallisation and its structure established as W-(2n-hexylcyclopropyl), 9: 10 decenoic acid on the basis of physical constants together with the spectroscopic, degradative and synthetic studies. This structure provides a plausible explanation for the unusual marked tendency of the oil towards polymerisation.**

Sterculia foetida Linn. (N. O. Stereuliaceae), commonly known as "Java olives or Jangli Badam', is mostly found in the Western and Southern parts of India, Burma and Ceylon and also widely distributed over East Tropical Africa, Borneo, Java, Sumatra, Indo-China, Malaya and North Australia (1. 2). The seed kernels contain about 54% of a pale yellow oil which polymerises slowly at ordinary temperature, but at 240-245° it gelatinises with spontaneous generation of heat into a rubber-like product.

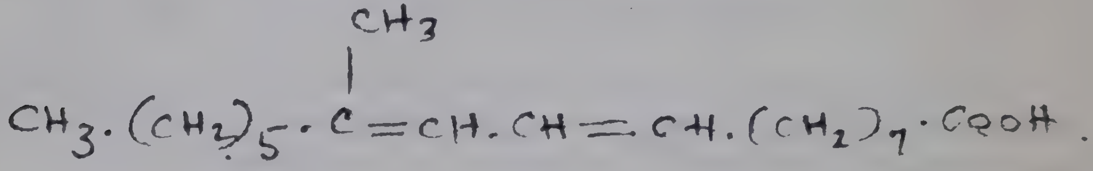
**TABLE I.**

**Characteristic of sterculia foetida oil**

| | |
|---|---|
| Sp. gravity, 40° | 0.9239 |
| Refractive index, 40° | 1.4658 |
| Browne heat test (Std.) | 4′-15″ |
| Browne heat test (250°) | 7′-15″ |
| Acid value | 6.5 |
| Saponification value | 179.4 |
| Iodine value (Wijs, ½ hr.) | 74.5 |
| Acetyl value | 2.5 |
| Unsaponifiable matter, % | 1.3 |

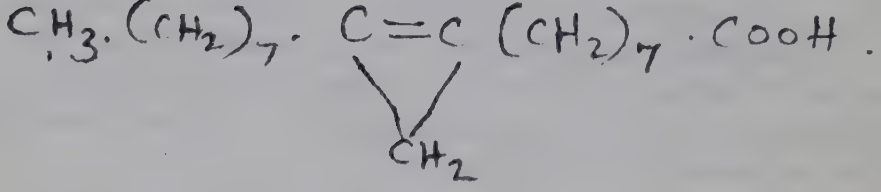
Steger and Van Loon (3), working on the mixed fatty acids, concluded that the acid responsible for this property was a saturated hydroxy acid, $C_{18}H_{34}O_4$. Hilditch, Meara and Zaky (4) distilled the hydrogenated mixed methyl esters and deduced that the original mixed acids contained 72% of a doubly unsaturated acid, $C_{19}H_{34}O_2$. Further, by degradative studies on oil as well as mixed methyl esters they concluded that the acid was 12-methyl octadeca-9: 11-dienoic acid (I).

Recently Nunn (5), through urea complexes fractionation isolated a ne $C_{19}$-acid, designated as sterculic acid, from the mixed fatty acids of the oil an assigned it the structure of W-(2n-octylcyclopropene)-octanoic acid (II).



$$CH_3.(CH_2)_5.\overset{CH_3}{\overset{|}{C}}=CH.CH=CH.(CH_2)_7.COOH.$$

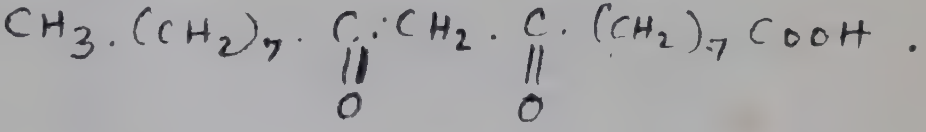
(I)



(II)

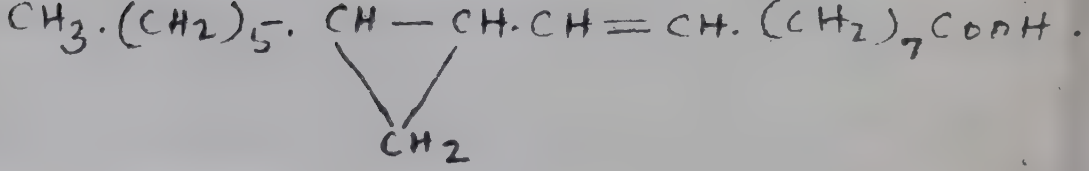
He based this mainly on (i) the detection of an infra-red absorption ban at 9.85 m μ characteristic of a cyclopropane group (6), in the spectrogram dihydrosterculic acid analogous to a $C_{19}$-saturated acid from Lactobacillu arabinosus (7) and (ii) a product of ozonolysis, $C_{19}H_{34}O_4$, which he characterise as 9: 11-diketo-nonadecanoic acid (III).

Sterculic acid, $C_{19}H_{32}O_2$, has now been separated from the mixed fatt acids by low-temperature fractional crystallisation in a colourless crystallin form, m.p. 19°, $n_D^{25}$ 1.4758. This has been assigned (9) a structure (IV) o the basis of physical constants together with spectroscopic degradative an synthetic studies.



$$CH_3.(CH_2)_7.\underset{O}{\underset{\|}{C}}.CH_2.\underset{O}{\underset{\|}{C}}.(CH_2)_7COOH.$$

(III)



(IV)

Nunn (5) has however not taken the infra-red absorption curve of sterculic acid itself and the position of the double bond seems to have been fixed on the product of ozonolysis (III) which, according to our experimental data comes out to be W—(2n-hexylcyclo-propyl) 10-keto-9-hydroxy-decanoic acid (V) or W—(2n-hexylcyclo-propyl) 10-hydroxy-9-keto-decanoic acid (VI). The spectdum (10) of sterculic acid gives clear indication of a cyclo-propane ring at 9.92 m μ and a double bond (C=C) at 6.09 m μ on the shoulder of the strong carbonyl band at 5.9 m μ.

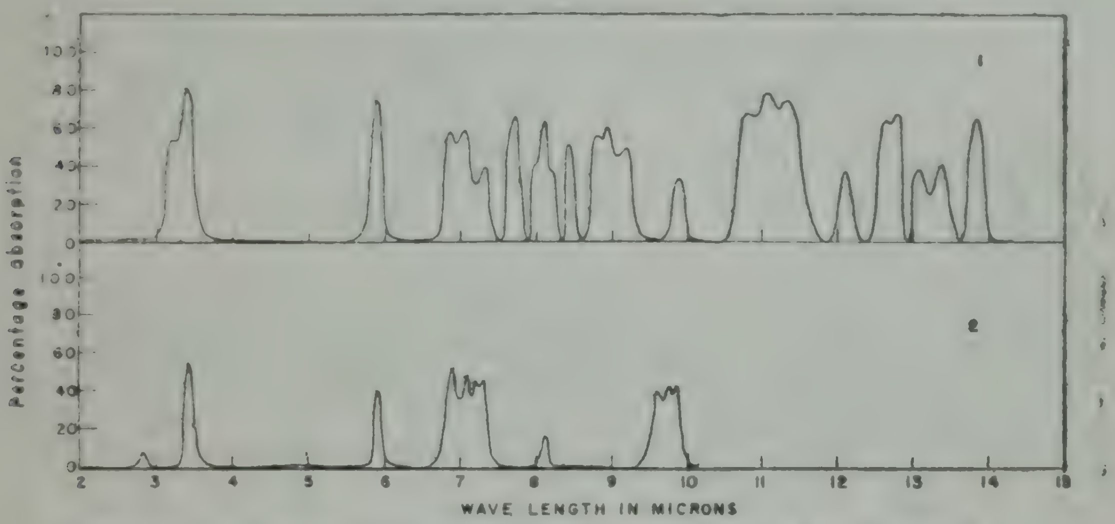
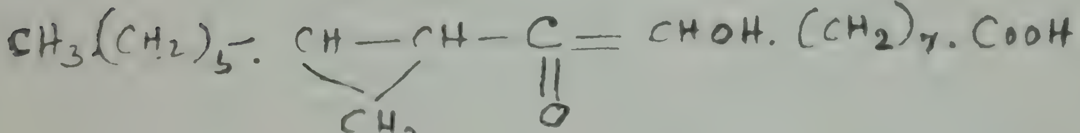
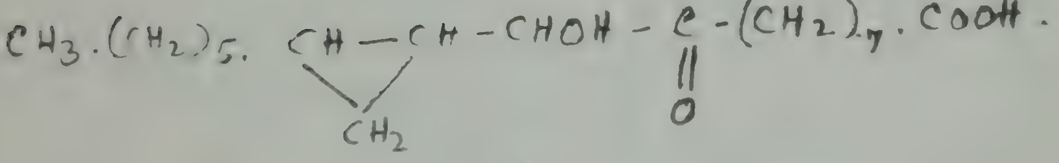


Fig 1 Infra-red absorption spectrum of w (2n-hexyl cyclopropyl) 10 keto-9 hydroxy decanoic acid. Fig. 2. $KIO_4$ – Oxidation product (Volatile)



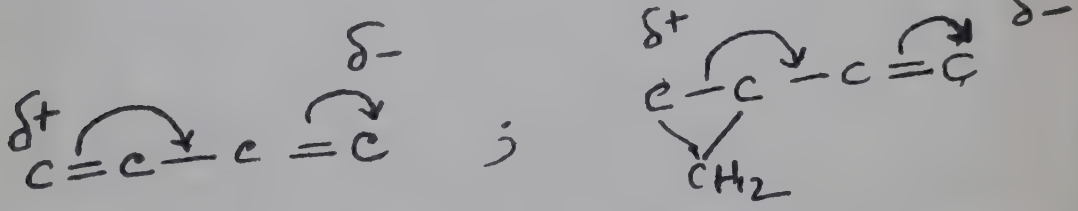
(V)



(VI)

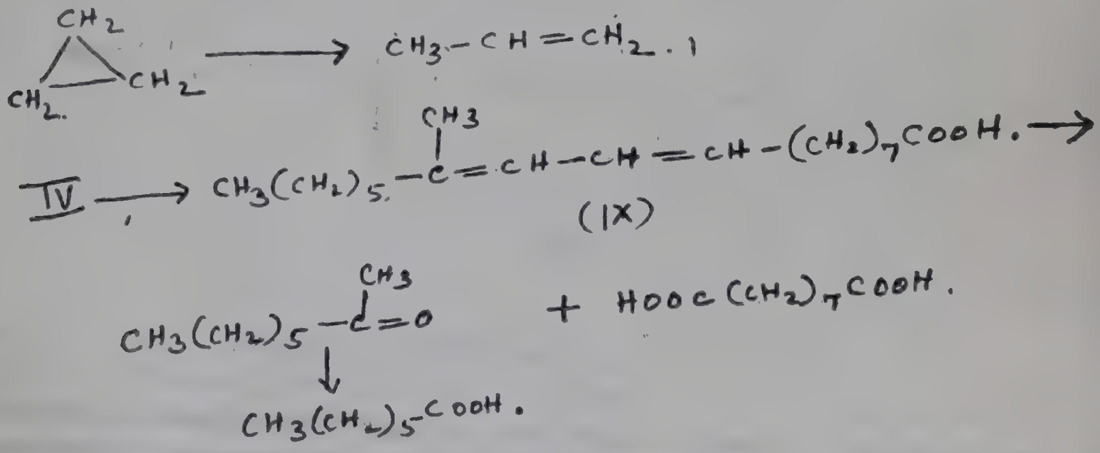
Iodine value (98.2, Wijs), diene value (40.3) and a marked tendency towards polymerisation observed for sterculic acid cannot be explained by structure (II) which contains a fairly stable, semi-aromatic, cyclopropane grouping (11). On the other hand, these characteristics indicate the presence of conjugated unsaturation which Hilditch, Meara and Zaky (4) had suggested tentative from the constants of the oil and the mixed methyl esters.

The cyclopropane ring exhibits typical unsaturation towards many speci reagents(12) and possibly forms in sterculic acid a conjugated system with th double bond resulting in structure (IV) which behaves very similar to a tru conjugated diene by virtue of polarities as shown below :



Sterculic acid consumed one mole of hydrogen in presence of Pd-CaCC of less than 5% concentration but with Adam's catalyst or Pd-CaCO$_3$ of mo than 5% concentrations it absorbed two moles of hydrogen giving n-nonadecano acid, m.p. 68-69° and a liquid mixture, probably of two methyl-substitute octadecanoic acids which could not be separated.

Oxidation of sterculic acid with potassium permanganate in acetone ga azelaic acid and a steam-volatile mixture consisting of heptylic acid, and meth hexyl ketone. Hilditch, Meara and Zaky (4) have also reported the isolation heptylic acid and methyl hexyl ketone from potassium permanganate oxidatic products of sterculia foetida oil and mixed methyl esters. This may be explaine on the assumption that oxidation is accompanied with isomerisation of cycl propane ring to a propylene compound analogous to the conversion of cycl propane into propylene. (13). The following steps are possibly involved durir the oxidation process :



Nunn (5), however, reports pelargonic acid as one of the oxidation produc which could not be confirmed.

Hydroxylation with $KMnO_4$ in cold yielded, as the main product, $C_{19}H_{34}O_4$, p. 62-62.5°, which has been characterised as (V) or (VI). Its infra-red sorption spectrum (Fig. I) includes a definite band at 9.92 mμ indicating thus, at the cyclopropane ring remains intact and only the double bond is attacked. formed a semicarbazone, m. p. 70° and gave a deep red colour with ferric loride characteristic of enol type (VII). Its ultra-violet curve (Fig. II) has a to band (14) at about 277 mμ (log E=4.02).

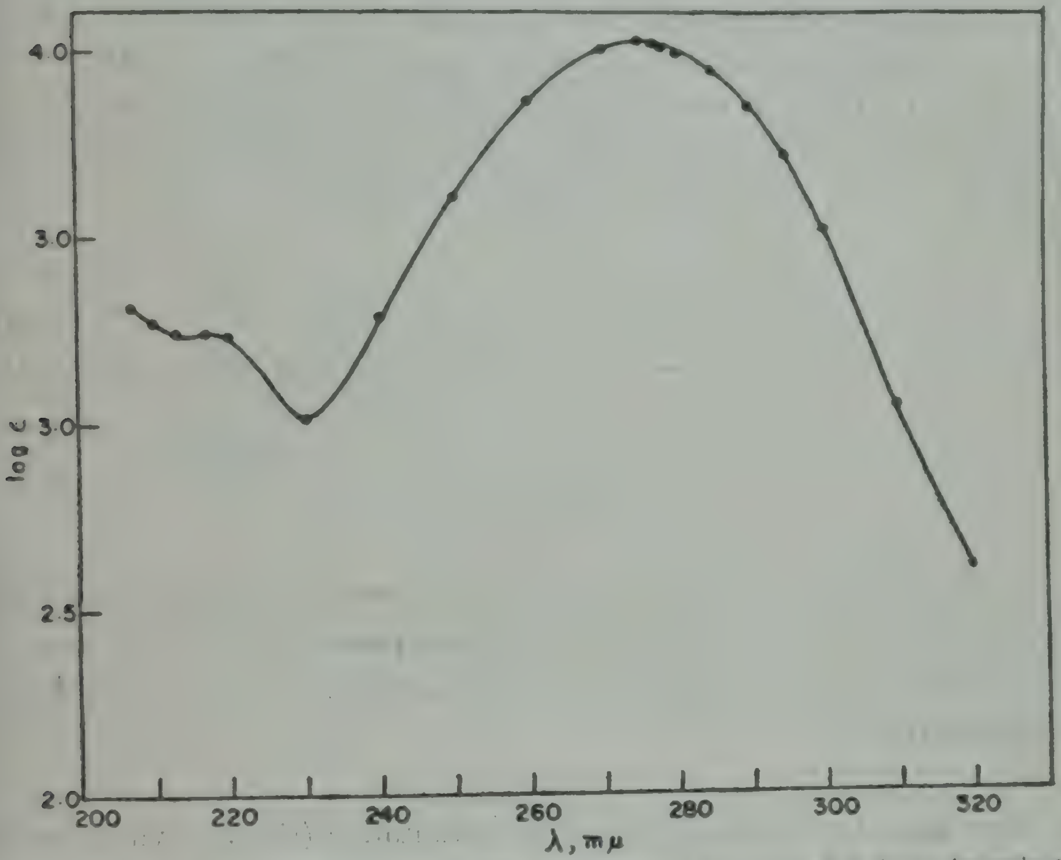
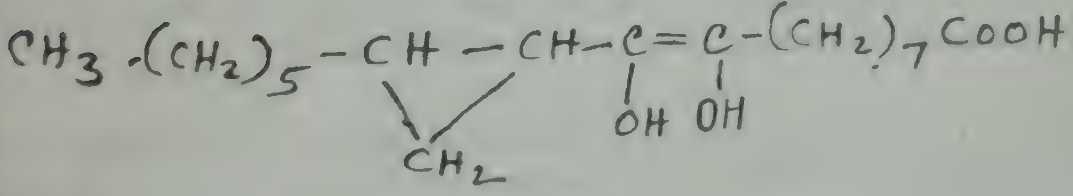


Fig. II. U-V Curve of ω (2n-hexyl cyclopropyl) 10-keto-9 hydroxy deconoic acid



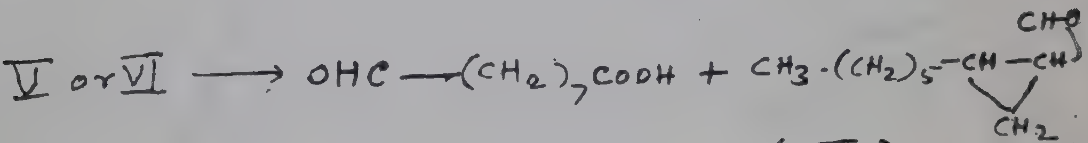
$$CH_3\cdot(CH_2)_5-\underset{\diagdown\ CH_2\ \diagup}{CH-CH}-\underset{OH}{\underset{|}{C}}=\underset{OH}{\underset{|}{C}}-(CH_2)_7COOH$$

(VII)

The formation of a monoketo product (V or VI) in place of the correspond- ng dihydroxy derivative is consistent with the known fact(15) that a mono-keto ompound generally results from oxidation of oleic acid.

When sterculic acid was ozonised in ethyl acetate at low temperature a the ozonide decomposed with hydrogen and palladised charcoal, a visc liquid was obtained from which a compound m.p.62°, slowly crystallised out a large amount. This was found to be identical with (V or VI) in respect mixed m.p. semicarbazone derivative and ultra violet and infra-red absorpti spectra.

The compound (V or VI), on oxidation with periodic acid, gave the sem aldehyde of azelaic acid, m.p. 58° and a highly volatile liquid, $C_{10}H_{18}O$, b 80°/2 m.m. This liquid responded to the usual aldehydic reactions and band at 9.85 m $\mu$ in its infra-red spectrum (Fig. I) suggests the presence of cyclopropane ring. These characteristics indicate the probable structure of th liquid as (VIII) and, therefore, the step-wise fission of (V or VI) may be r presented as :



(VIII)

Iodine number which is equivalent to more than one double bond, diene valu infra-red spectral evidence and the degradative products presented above, a lead to structure (IV) for sterculic acid. These facts do not, at any rate, i the structure (II).

Further methyl ester of an acid of the constitution (II) was synthesised (1 by the action of diasomethane on stearolic acid and the product, $C_{20}H_{36}O_2$ b. 105-110°/4 mm., was found to be fairly stable and could be vacuum-distille without appreciable decomposition. Its stability, iodine (80.6) and diene valu (5.3) and infra-red absorption curve are quite different from those of stercul acid. Therefore sterculic acid cannot have structure (II).

As regards polymerisation of sterculic acid, Nunn's (5) postulation that t acid polymerises by reaction of the carboxyl group with the double bond, do not seem to be correct for want of any experimental data. On the other han under the influence of heat, the structure (IV) may change transitionally to (I containing a true diene system which as is well known leads to polymerisatio We find from our preliminary experiments, that the cyclopropane ring in ste culic acid vanishes when the acid is subjected to heat for sometime resulti into gelatinization.

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# KAMALA SEED OIL IN PAINTS AND VARNISHES

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**Kamala seed oil extracted with petroleum solvents gives air-drying wrinkle finish coatings and alkyd resins similar to those obtained from tung oil. Work is in progress to utilise the entire Kamala seed oil extractable with benzene in paints and varnishes, especially in the preparation of smooth coatings.**

Suitability of an oil in surface coatings is indicated besides other characteristics, by its iodine value and the percentage of polyethenoid acids, or by kinds of unsaturated glycerides present in it. Kamala seed oil has an iodine value of 160-183 and contains 58-60% kamlolenic acid. Its quick drying nature has in it a potential substitute of tung oil in India.

It has been observed that Kamala seed oil cannot be obtained by expression in hydraulic presses, ghannies or expellers. Only organic solvents extract the oil. Petroleum ether extracts 16-20% oil containing 37-42% kamalolenic acid, whereas benzene, ethyl ether and ethyl acetate extract 35-40% oil with 55-60% kamalolenic acid content. Chlorinated solvents and acetone are not suitable for the purpose (5). Browners' heat test for petroleum ether extracted oil is 8-10 min. whereas oil extracted by ethyl acetate, benzene or ethyl ether gels in about 2½ mts., under similar conditions. Tung oil has a gelation time of 9-15 mts.

To avoid the use of solvent, kamala seed oil has been extracted at the Forest Research Institute, Dehra Dun (6), by liquid-liquid extraction method, using some high boiling solvents like turpentine and xylene, less viscous oils such as linseed or sesame oils, which do not deposit solid glycerides on cooling to 0-5°C. By twice extracting and centrifuging, a mixture of oils is obtained from which kamala seed oil is separated by cooling to 0-5°C. and centrifuging. The cake having 30% solvent-oil mixture is pressed in a hydraulic press. This oil has been named as 'FRIOL'.

Kamala seed oil dries like tung oil to give a frosted effect on a glass or metal plate. If a small amount of drier is added to it the oil sets to a wrinkled pattern on drying in air.

Air drying wrinkle finish coatings from kamala seed oil have been prepared at the National Chemical Laboratory(7). They prepared oleoresinous varnishes from kamala seed oil alone and also in admixture with linseed, tobacco seed and safffower seed oils and dehydrated castor oil to the extent of 75% with ester gum, "Bedesols", congo-copal and other wrinkling resins.

Medium and long oil length varnishes were prepared. In the case of kamala seed oil when used alone, oil and the resin were heated and mixed together. The mixture was then cooked at 200-225°C till the run gave 8-10 inches long thread. After thinning with low boiling solvents such as benzene, toluene or coal tar naphtha, and adding driers the varnish was sprayed on glass and metal plates. These films set to wrinkle patterns on drying in air in 1½ to 2 hrs.

When mixtures of kamala seed oil and other drying oils were used, resin and the latter type of oils were cooked first at 230-250°C for some time. The contents were cooled to 200°C and the required amount of kanala seed oil was added. Cooking was continued at 200-220°C. Rest of the procedure was the same as mentioned above. For preparing air drying wrinkling paint, required amounts of pigments such as titanium dioxide, lithopone, zinc oxide, and chrome pigments were mixed with the varnish base and then thinned with the solvents. These varnishes and paints gave air drying wrinkle finishes with good adhesion, hardness, flexibility and resistance to water, alkali, acid and organic solvents. These films could be applied on all surfaces whether absorbent such as cloth, paper, wood, masonite, cement-boards and earthern ware etc. or non-absorbents, such as glass and metal sheets, of course, after proper treatment of absorbent surfaces so as to make them non-porous.

Films of varnishes prepared from 'FRIOL' are found to be much inferior to those of tung oil but definitely better than linseed and dehydrated castor oil varnishes (8). These films did not set to wrinkles on drying. This may be due to the other oils (9) present in 'FRIOL' and the use of high boiling thinner in the coating compositions prepared from this material or due to the absence of required thickness of the flim on the plate.

Oil modified alkyd resins from petroleum ether-extracted kamala seed oil fatty acids have also been prepared. Kamala seed oil fatty acids can be substituted by the fatty acids of linseed, safflower and tobaccoseed oils to the extent of 50%. The films of these coatings give hard and flexible wrinkle finishes on baking, and are quite resistant to water, acids, alkali and organic solvents. In general, medium oil alkyd resins were found superior to short and long oil modified resins. Partial substitution of phthalic anhydride by maleic anhydride increases the qualities of the film to a certain extent.

Recently resins have been prepared from the mixed fatty acids of benzene-extracted kamala seed oil and kamlolenic acid (11). As the benzene-extracted kamala seed oil and kamalolenic acid gel very rapidly even at low temperatures, long oil alkyd resins could not be prepared from these materials. Even for the preparation of medium oil alkyd resins 10-15 per cent excess of glycerine had to be used to bring down the acid value of the resin below 15 and milder cooking conditions, viz., 2-4 hrs. at 150-210°C and 5-8 minutes at 210-225°C, were employed to avoid gelation. It was generally observed that the preparation of the resin was comparatively easy and chances of gelation were much minimised when kamala seed oil fatty acids or kamalolenic acid were partly substituted by the fatty acids of other drying oils. The films of such resins were harder than those prepared from compositions having kamala seed oil fatty acids only. The films were unaffected in ordinary and sea-water and 10 per cent sulphuric acid even after immersion for 72, 48 and 24 hrs. respectively. They were also quite resistant to petroleum ether, mineral spirit and mineral lubricating oils but not to benzene, toluene, xylene, and coal tar naphtha. The films became hard on drying and freeing them of the solvent. If a part of phthalic anhydride is substituted by maleic anhydride, the films become more resistant to various solvents.

Resins were also prepared from 18-hydroxystearic acid and hexadecamethylene 1 : 16-dicarboxylic acid. They were pale coloured, fairly hard and quite soluble in benzene and benzene-alcohol mixtures (1 : 1) but were partially soluble in alcohol alone.

It has also been reported (12) that kamala seed oil can be used only for wrinkle finishes and not for the production of smooth coatings. Preliminary work conducted at the N.C.L. has however, shown that the petroleum ether-extracted kamala seed oil can be used for smooth finishes. Work is in progress to study the effect of heat at various temperatures on benzene and peroleum ether-extracted kamala seed oils and to compare them with tung oil under similar conditions. The basic idea of this work is to harness the very rapid polymerising properties of kamala seed oil in the preparation of various coating compositions. Once this is achieved it is expected that this indigenous raw material will not go to waste and will be much prized for the production of coatings as a substitute of tung oil which is mostly imported in our country.

It has also been found (13) that the keeping time of kamala seed oil can be increased to about four times if 0.1 per cent hydroquinone is mixed with it. Hexane-extracted kamala seed oil can thus be kept at ordinery temperature for about six months and benzene-extracted oil for 2 to 3 months without gelation.

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# UTILIZATION OF GLYCERINE IN ALKYD RESINS

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**The present position of the glycerine industry in India is reviewed with reference to the developments in India in the production of alkyd resins and the international trends in the glycerine production and end use applications. In view of the anticipated increased demands for glycerine in the internal markets and the profitable export markets, it is suggested that all possibilities for increasing the production of glycerine should be explored.**

Glycerine industry in India is one of the few industries which has attained self-sufficiency, besides having an exportable surplus (1, 2). Being a by-product of the soap industry, the extent of production of glycerine is dependent on the trends in the soap industry. The current production is about 2,500 tons per annum out of which 400 to 800 tons are exported on an average and the rest consumed in the country. The installed capacity for refined glycerine in 1954 was 3,516 tons and this left a surplus productive capacity of about 1,000 tons (Table 1). The potential available glycerine from the soap industry is much more, but spent lye recovery is limited to a very few of the soap plants, and even in these plants, the actual production of soap is far below the installed capacity. These two factors have been restricting the actual production of glycerine to around 2,500 tons per annum despite the lucrative export markets. Soap industry is well aware of the significant role of glycerine, but considering the practical difficulties of the indigenous soap industry, it is rather difficult to say how soon the position of the glycerine industry would improve further.

About 75% of the glycerine consumed in India is used in textile, pharmaceutical, chemical and other industries, while the remaining 25% is used in the hospitals, chemists and druggists shops, and for several miscellaneous applications (Table 2). In consequence of the general industrial expansion in the country envisaged during the coming years, an increase in demand for glycerine in the internal markets can be expected. The trends in the paint and varnish industry would be of particular interest to the glycerine industry.

### Table 1.

### Position of Glycerine Industry in India.

| Year | Annual figures in Tons | | | |
|---|---|---|---|---|
| | Installed capacity [*] | Production [*] | Consumption [**] | Export [**] |
| 1947 | 3.156 | 1,332 | 1.047 | 289 |
| 1948 | ,, | 2.148 | 1,594 | 16 |
| 1949 | ,, | 1,740 | 1,135 | 387 |
| 1950 | ,, | 2,004 | 1.816 | 419 |
| 1951 | 3,198 | 2,424 | N. A. | 435 |
| 1952 | 3,516 | 2,220 | 1,406 | 806 |
| 1953 | ,, | 2,508 | 1,794 | 850 |
| 1954 | ,, | 2,397 | 1,934 | 389 |
| 1955 (six months Jan-June) | 5,160 | 1,278 | — | — |

[*] These are computed from the information in the monthly statistics of the production of selected industries of India, July 1955 issue of the Ministry of Commerce and Industry, Directorate of Industrial Statistics, Calcutta. In the above reference, the monthly averages are given and these are converted into annual by multiplying by 12. So there is likely to be a variation of plus or minus 6 from the actual figures.

[**] These are based on private information obtained by the authors and may be regarded as approximate. They are included to give an indication of the trends in international consumption and export.

### Table 2.

### Estimated consumption of glycerine in India by different groups of industries.[*]

| Industry | Percentage |
|---|---|
| 1. Textile Industries ... ... | 8.5 |
| 2. Pharmaceutical Industries ... ... | 21.6 |
| 3. Chemical Industry ... ... | 26.0 |
| 4. Other Industries ... ... ... | 20.0 |
| 5. Hospitals and Dispensaries ... ... | 3.2 |
| 6. Chemists and Druggists ... ... | 17.9 |
| 7. Others ... ... | 2.8 |
| | 100.0 |

[*] This estimate is based on the information available around 1951, and is indicative of the trends at this period. In the subsequent years, there might have been a change in the proportionate consumption of glycerine among the different groups of industries in view of the expansion of some of the chemical industries.

The dual role of surface coatings as both protective and decorative media for the underlying surface of wood or metal is now being better realised and surface coatings are no longer regarded as luxuries. The remarkable contribution of synthetic resins towards the formulation of superior surface coatings is well known and in the Western countries substantial tonnage of the various synthetic resins is being used by the paint, varnish and lacquer industries. The latest trends in the paint and varnish industry in India indicate that during the last two or three years a slow beginning in this direction is made with encouraging results. The imports of synthetic resins and emulsion paints based on synthetic resins are fast increasing and serious efforts are being made to produce these locally, wherever possible, importing the necessary raw materials. Alkyd resins are by far the most important amongst the synthetic resins used is surface coatings.

Several types of modified alkyds are used in the surface coatings industry such as the more popular oil modified alkyds, styrenated alkyds, and silicone modified alkyds. Interest is evinced by the indigenous paint manufacturers in all these types of alkyds. However, the current interest seems to be largely in the oil modified alkyds, particularly medium to long oil modified alkyds based on linseed oil, dehydrated castor oil, soyabean oil and tung oil. Tung oil is being imported in small quantities. Soyabean oil modified alkyds are being imported in small quantities to avail of the special characteristics of non-yellowing of the film on ageing attributed to this type of alkyd, but the latest trend seems to be to watch how far this advantage prevails under tropical conditions. The other types of alkyds are being imported in limited quantities to supplement the small quantum of indigenous production.

The current production of alkyd resins in India is estimated at 300 tons per annum. Five units are possibly engaged in the regular production, two in Calcutta, two in Bombay and one in Madras, with the main object of meeting their own requirements. In some sections of the industry, it is felt that there is scope for one more unit to cater to the needs of the many small paint manufacturers in the country. This is, no doubt, an encouraging feature, indicative of the increasing popularity of alkyd resins, but, in planning the development of the alkyd resin industry, one should not lose sight of the fact that economic units are desirable to produce quality products at competitive costs.

Apart from the modifying fixed oil, glycerine and phthalic anhydride are the two essential raw materials required for the manufacture of oil modified alkyds. Glycerine is available from indigenous sources. From the import figures, it appears that about 78 tons of phthalic anhydride was imported during 1954 April to 1955 March. Phthalic anhydride can be replaced to a small extent by maleic anhydride, and small quantities of this product also were imported during the same period. Several other polybasic acids can be used and are being used in substantial quantities abroad to produce modified alkyds, but alkyds of these modified types have not yet become popular in India.

Alkyds are polyesters formed by the polycondensation of polyhydric alcohols such as glycerol with polybasic acids such as phthalic anhydride. While glycerine has saveral advantages over the other commercially available polyhydroxy alcohols such as ethylene glycol, diethylene glycol, propylene glycol, pentaerythritol and sorbitol, and on this score continues to be the most essential polyol for alkyds manufacture, the other polyols find use to a limited extent to partly replace glycerine to modify the properties of the alkyds. From amongst these glycerine substitutes, pentaerythritol is being utilized by the producers of alkyds in India, as is seen from the import of about 25 to 30 tons of this commodity during 1954 to 1955. It would be difficult to say whether this material was imported to avail of the special characteristics obtainable from this type of modified alkyd or on other considerations.

From the above trends, it can be taken that a real beginning has been made in the development of alkyd resins in India. The major application of these resins is in the formulation of superior quality surface coatings or industrial finishes. The expansion under progress in the automobile, bicycle, sewing machines, and similar other industries is an indication of the prospective role of industrial finishes. The trends in these industries should as well be of interest to the glycerine industry.

**International trends in the glycerine industry.**

In these days of keen international competition, we cannot afford to lose sight of the international trends, both the immediate as also the long range ones. The trends in the U.S.A. and in Europe would be of some interest in this connection.

In the U.S.A., soap industry has become a bit hesitant about its future in consequence of the rapid developments in the synthetic detergents field. There has been a slight decline in the consumption of soap in the recent years and it is envisaged that there may be a slight further decline in soap consumption in the coming years. But, in some of the Asiatic countries where the per capita consumption of soap now is very low, an increase in the production and consumption of soap is expected. As a net result, it is expected that by 1970, the world production of soap would decline by about 11%. This means that there would be a decline in the by-product glycerine obtainable from the soap industry.

The other source of by-product glycerine is from the fat-splitting industry. This industry is well established in the U.S.A., and the recently developed more economical and more efficient methods of autoclave fat-splitting processes are being adopted in U. K. and Europe. By-product glycerine from this source would continue to be available in the coming years, may be in slightly larger quantities.

In the U.S.A. it is expected that the quantity of by-product glycerine obtainable from the above two sources would appreciably fall short of the increasing demands for industrial glycerine. This contingency has been visualised even much earlier and it was the synthetic glycerine that saved the situation. Shell Chemical Co. has taken the initiative in this direction in developing the synthetic glycerine process based on propylene. As per the recent reports, out of the 207 million pounds of industrial glycerine produced in the U.S.A., 149 million pounds is by-product glycerine and 58 million pounds is synthetic glycerine. So, even by now, the glycerine picture in the U.S.A., has changed from that of a 100% by-product commodity to that of a 30% synthetic and 70% by-product commodity. About 70% of the current consumption of glycerine in that country is in the alkyds industry and it is expected that in the coming years the demand for alkyds would increase many times. Side by side, rapid developments in the other industries consuming large proportions of glycerine are also expected. To meet these anticipated increased demands in the coming years, increased production of synthetic glycerine at competitive rates is the logical solution for the U.S.A. Dow Chemical Co., has just gone into production of synthetic glycerine, and it is expected that Shell would increase their synthetic glycerine facilities. An alternative process for the manufacture of synthetic glycerine, also based on propylene, has been indicated as the most probable process that would be introduced by Shell in their next move. These developments in the U.S.A. are in a way the natural outcome of the long range projects for expansion of the petrochemical industry in that country.

European countries seem to be in increasing need for glycerine to meet the demands of their expansion programmes. As an instance, it was recently reported that Argentina which was customarily exporting crude glycerine to the U. S. A. for processing to refined glycerine has now found more profitable markets on the Continent. It is likely that the surplus exportable glycerine from the glycerine producing countries may for at least a few years to come find markets in Europe.

Fermentation process offers the third source for glycerine and this is once again attracting attention. In U. K., it is reported, pilot plant studies are in progress on the production of glycerine by fermantation of molasses.

Considering the internal and international trends discussed above, it appears advisable that all serious efforts are made to recover as much of glycerine as possible and increase the production of glycerine in India.

The authors wish to express their thanks to our sales organisation for co-operation in preparing this paper and to the Tata Oil Mills Co. Ltd., for permission to present this paper.

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# AFTER-TACK IN DEHYDRATED CASTOR OIL

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The dehydration of castor oil is brought about by a number of catalysts under different conditions of temperature, pressure, concentration of the catalysts, and period of reaction. This modified drying oil has unique combination of properties and has many advantages over tung oil and linseed oil. Dehydrated castor oil, however, possesses an undesirable property of after-tack. After-tack is rather difficult to explain than to feel it and realise it. If you gently press your thumb against a dry film of dehydrated castor oil, you feel a sort of pull when trying to remove the thumb. The film however, is not affected in any way. There are many devices to measure tack but they are all qualitative. After-tack in dehydrated castor oil was first noticed in 1938-40.(1) Many reasons for after-tack have been put forth by various workers in this field. Much of this work has been summarized by Wilson.(2) He attributes this effect of after-tack to the presence of decomposition products, undehydrated castor oil, hydrolysed products, etc. He also suggests that this after-tack may be due to geometrical isomers in which there is difference in uptake of oxygen between trans and cis isomers. After-tack may be overcome, he further adds, by increasing the functionality of the molecule by condensing the fatty acids of dehydrated castor oil with higher polyhydric alcohols such as, pentaerythritol, sorbitol, etc., and by maleinisation of oil.

Recently it has been suggested that after-tack is associated with conjugation present in dehydrated castor oil, since after-tack was noticed in 9, 11 linoleic acid, but was absent in 9, 12 linoleic acid. It was also suggested to develop a method for obtaining dehydrated castor oil with more of 9, 12 linoleic acid.(3) Teeter H. M. (4) observes that development of conjugation in isomerised linseed oil is known to lead to after-tack; however, recently Von Mikusch(5) has reported that isomerised linseed oil 'ILO' which is said to be highly conjugated and rich in trans isomer, is free from after-tack. It seems, therefore, that trans isomer and conjugation are not responsible for after-tack. The large quantity of unsaponifiable matter may also lead to after-tack but dehydrated castor oil contains a neglible quantity of unsaponifiable matter. Wilson (2) reports that dehydrated castor oil of low viscosity prepared by low pressure dehydration has minimum after-tack, but heat polymerisation of such oils increases after-tack.

H. S. Lilley and R. J. Carter (6) reported that though the average molecular weight of dehydrated castor oil is approximately equal to that of other drying oils, such as, linseed oil and soyabean oil, it contains several species of glycerides each possessing different molecular weight, Dehydrated castor oil contains more large and more small molecules than equivalent linseed oil; as gelation through oxidation proceeds this disparity increases and in a 'set D. C. O. film there will be proportion of small molecules not present i gelled linseed oil film; in fact, the distribution of species in two films will more disparate than in bulk oils. After-tack in D. C. O. films may be due these small molecules. As the amount of cross linking agent is controlled af set up by diffusion, they (small molecules) will have little chance to build into film forming molecules and as liquid species they will synerise out of t gel and cause after-tack effect. For cases where the drying potentials a enhanced by the presence of tri-ene system the rate of film formation is grea and stronger films can be formed than in diene systems with the result th triene systems do not show after-tack.

Dehydration of castor oil is accompanied by side reactions such polymerisation, decomposition, hydrolysis, isomerisation, and estolide form tion. These side reactions cause to form many species of oils with differe molecular weights. Some of these species, such as free fatty acids, mono a di glycerides decomposition products, undehydrated castor oil are non dryi constituents of raw dehydrated castor oil. If these species are separated fro the oil, there should be no after-tack in the separated oil. With this view mind dehydrated castor oil was fractionated with iso-propyl alcohol into thre fractions and their properties were studied.

**Experimental Procedure :**

The dehydration of castor oil was carried out under two sets of condition (a) Atmospheric pressure, (b) Reduced pressure.

100 grams of dehydrated castor oil were mixed with 400 grams of iso propyl alcohol in a litre flask and solution was gradually heated on water bat with stirring from time to time till the oil was completely soluble. Th temperature at the point of transparancy was noted. Then the solution wa slowly cooled till the first turbidity appeared. The temperature at which th turbidity appeared was noted and mean temperature of both the points wa taken as solubility temperature. The solution was then poured in a jackete separating funnel and kept at a temperature 10°C. below the solubility tempera ture of the solution. The mixture was allowed to remain at that temperatur for 30 minutes. Then the lower separated fraction was tapped into a clea previously weighed conical flask (first fraction). The temperature of th solution was further lowered successively upto —10°C. The fractions separate upto 10°C. were collected together as a second fraction. The fraction remain ing in solution was the third fraction. The temperature of —10°C. was obtaine by using ice and salt mixture. The solvent from all the three fractions wa distilled off and the last traces were removed under vacuum. After weighin the flasks percentages of individual fractions were determined. Fraction were studied for film properties and following values.

) Values :—

(1) Iodine value by Woburn method.

(2) Acid value.

(3) Hydroxyl value by acetic anhydride and pyridine solution.

(4) Molecular weight (cryoscopic method using benzene).

(5) Refractive Index at 40°C. on Abbe's refractometer.

(6) Colour determined on Lovibond Tintometer in Y, B, R, units using a cell of 10 mm. thickness.

3) Film properties :—

(1) Drying time on drying time recorder.

(2) Cold water resistance.

(3) Alkali resistance (0.1 N. NaOH).

(4) Solvent resistance (benzene).

The film properties were determined after using 0.04% cobalt naphthenate nd 0.4% lead naphthenate dryers (on weight of metal). The oil film containng dryer was applied on a glass plate 6″ x 3″ size with a brush. The plates vere then suspended vertically to have uniform film thickness. The films vere dried and aged for 72 hours in an air thermostat maintained at 30°C. nd 30 to 32% relative humidity.

### Experiment No. I.

**Catalyst :—** Benzene sulphonic acid.

Conditions of dehydration :— Atmoospheric pressure (713 mm.)
concentration of the catalyst: 0.3%;
Period of reaction : 60 minutes.
Temperature of reaction : 250°C
+ or – 5°C.

Solubility temperature: 43.5°C.

| | Dehydrated castor oil | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|
| Temperature | — | 33.5°C. | 33.5°C to —10°C. | — 10°C. |
| Yield | — | 29.7% | 40.3% | 30% |
| Iodine value Woburn | 141.7 | 136.3 | 141 | 142 |
| Acid value | 17.2 | 4.6 | 4.8 | 34.8 |
| Hydroxyl value | 35.8 | 10.7 | 12.4 | 54.8 |
| Molecular weight (cryoscopic) | 943.9 | 1076 | 987 | 706 |
| Refractive Index at 40°C | 1.4750 | 1.4775 | 1.4770 | 1.4725 |
| Colour Lovibond 10 mm cell Y— | 13 | 15 | 12 | 12 |
| B— | 2 | 4 | 0.4 | 0.4 |
| R— | 7 | 12 | 5 | 5 |
| Drying time T.D. | 6 Hrs. | 2 Hrs. | 3 Hrs. | Film does not dry for 72 Hrs. |
| ,, ,, C.D. | 20 ,, | 14 ,, | 18 ,, | |
| After-tack | Film shows after-tack | Very little after-tack | | — |
| Water resistance | Whitening opaque disappeared within 2 hrs. | Whitening opaque disappeared within 20 minutes | | Film being wet, partially washed off |
| Alkali resistance | Film dissolved in 5 minutes | Film disolved in 10 minutes | | Film dissolved completely in 5 minutes |
| Solvent resistance | Film partially dissolved | Film swells considerably & peeled off | | Film dissolved completely |

T.D. — Touch dry. C.D. — Complete dry.

## Experiment No. II.

Catalyst :—Benzene sulphonic acid
Conditions of dehydration :—Reduced pressure 10 mm. of mercury.
Other conditions are the same as experiment No. I
Solubility temperature 45°C.

| | | Dehydrated castor oil | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|---|
| Temperature | | — | 35°C. | 35°C to —10°C | —10°C. |
| Yield | | — | 41.75% | 29.85% | 28.4% |
| Iodine value Woburn | | 136.4 | 138.7 | 140.9 | 128.65 |
| Acid value | | 14.8 | 5.8 | 6.3 | 37.6 |
| Hydroxyl value | | 24.8 | 5.8 | 6.3 | 41.7 |
| Molecular weight (Cryoscopic) | | 1155 | 1334 | 1065 | 886 |
| Refractive Index at 40°C. | | 1.4770 | 1.4770 | 1.4790 | 1.4740 |
| Colour Lovibond 10 mm. Cell. | Y | 15 | 15 | 3 | 14 |
| | B | 0 | 0 | 0 | 0 |
| | R | 3 | 2 | 0.4 | 5 |
| Drying time T. D. | | 5 Hrs. | 2 Hrs. | 2 Hors. | 7 Hrs. |
| .. .. C. D. | | 15 ,, | 9 .. | 12 ,, | 24 .. |
| After-tack | | Film shows after-tack | Almost tack free film | | Film has considerable after-tack |
| Water resistance | | Whitening opaque disappeared within one hour | Whitening opaque disappeared within in 20 minutes | | Film covered with uniform white spots disappeared after 1 Hrs. |
| Alkali resistance | | Film foggy dissolved in 10 minutes | Film swells up considerably; dissolved in 15 minutes. | | Film dissolves in 5 minutes |
| Solvent resistance | | Film partially dissolved | Film swells up and peeled off. | | Film dissolved completely |

T.D. -- Touch dry. C.D. — Complete dry.

## Experiment No. III

Catalyst:—Anthraquinone 1 : 8 disulphonic acid.
Conditions of dehydration: at atmospheric pressure (713 mm.).
Concentration of the catalyst:—0.2%
Period of reaction:—60 minutes
Temperature of reaction: 250°C + or —5°C.
Solubility temperature 60.5°C.

| | Dehydrated Castor oil | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|
| Temperature ... | — | 50.5° | 50.5°C to — 10°C | —10°C |
| Yield ... | — | 22.0% | 48.0% | 30.0% |
| Iodine value Wöburn ... | 152 | 150.8 | 151.3 | 153.8 |
| Acid value ... | 22.6 | 6.5 | 7.9 | 58 |
| Hydroxyl value ... | 23.3 | 10.1 | 15.4 | 44.6 |
| Molecular weight (cryoscopic) ... | 981.9 | 1277 | 951.7 | 576.9 |
| Refractive Index at 40°C. ... | 1.4783 | 1.4830 | 1.4785 | 1.4720 |
| Colour Lovibond 10 mm cell Y | 18 | 18 | 20 | 20 |
| B | 2 | 2 | 2 | 2 |
| R | 14 | 20 | 8 | 18 |
| Drying time T.D. | 1½ Hrs. | 1 Hrs. | 2¼ Hrs. | Film does not dry even for 72 hours. |
| ,, ,, C.D. | 8 ,, | 6 .. | 8½ ,, | |
| After-tack ... | Film shows after-tack | Film tack free. | Film tack free. | ,, |
| Water resistance | Whitening opaque, disappeared in one hour. | Very slight whitening disappeared in 20 minutes. | Slight whitening disappeared in 20 minutes. | Film covered with white spots disappeared in 20 minutes. |
| Alkali resistance | Film dissolved in 5 minutes. | Film heavily swollen, does not dissolve for 20 minutes but removed from the glass plate. | | Film dissolves completely in 5 minutes. |
| Solvent resistance | Film only slightly dissolved. | Film swells considerably; peeled off from the plate. | | Film dissolves partially. |

T.D.=Touch dry; C.D.=Complete dry.

## Experiment No. IV

Catalyst:—Anthraquinone 1 : 8 disulphonic acid.

Dehydration carried out under reduced pressure 10 mm. of mercury.

Other conditions same as atmospheric pressure.

Solubility temperature 62°C.

| | Dehydrated Castor oil | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|
| Temperature | – | 52°C. | 52°C. to —10°C. | —10°C. |
| Yield | — | 24% | 65% | 20% |
| Iodine value Wöburn | 158.8 | 152.7 | 157.7 | 100.3 |
| Acid value | 19.2 | 3.2 | 7.8 | 62.23 |
| Hydroxyl value | 19.8 | 4.9 | 10 | 72.6 |
| Molecular weight (cryoscopic) | 991.7 | 1302 | 868.8 | 578.6 |
| Refractive Index at 40°C. | 1.4795 | 1.4827 | 1.4807 | 1.4740 |
| Colour Lovibond Y | 19 | 19 | 19 | – |
| 10 mm B | 1 | 1 | 1 | |
| cell R | 14 | 16 | 7 | – |
| Drying time T.D. | 2 Hrs. | 1 Hrs. | 2 Hrs | Film does not dry for 72 hours. |
| ,, ,, C.D. | 8 ,, | 6 ,, | 7½ ,, | |
| After-tack | Film shows little tack | Film tack free | Film tack free | ,, |
| Water resistance | Whitening opaque disappeared in one hour. | Film only foggy, slight whitening disappeared in 20 minutes. | | White uniform spots disappeared in 1 hour. |
| Alkali resistance | Film dissolved in 10 minutes. | Film slightly swollen, does not dissolve in 20 minutes, but loosened from the plate. | | Film dissolves completely in 5 minutes. |
| Solvent resistance | Very small swelling, does not peel off. | Film heavily swollen, peeled off. | | Film dissolved completely. |

T.D.=Touch dry; C.D.=Complete dry.

## Experiment No. V

Catalyst:—'Instantaneous',
Conditions of dehydration at atmospheric pressure. (713 m.m.).
Concentration of the catalyst: 0.2%
Period of reaction: 6 minutes.
Temperature of reaction 210°C. ± 5°C.
Solubility temperature 70°C.

| | Dehydrated Castor oil | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|
| Temperature ... | — | 60°C. | 60°C. to — 10°C. | —10°C. |
| Yield ... | — | 34% | 36% | 30% |
| Iodine value Wöburn ... | 170.7 | 163.5 | 176.3 | 159.5 |
| Acid value ... | 10.4 | 3 | 3.4 | 27 |
| Hydroxyl value ... | 19.8 | 7 | 6.7 | 50.46 |
| Molecular weight (cryoscopic) ... | 1391 | 2035 | 1379 | 883.7 |
| Refractive Index at 40°C. ... | 1.4805 | 1.4827 | 1.4805 | 1.4765 |
| Colour Lovibond 10 mm cell Y | 14 | 16 | 16 | 19 |
| B | 0.4 | 0.6 | 0 | 0 |
| R | 10 | 17 | 3 | 0.6 |
| Drying time T.D. | 1.5 Hrs. | 1 Hrs. | 1 Hrs. | 2 Hrs. |
| ,, ,, C.D. | 5 ,, | 3 ,, | 3 ,, | 8 ,, |
| After-tack ... | Film shows after-tack. | Film does not show any after-tack. | | Film shows after-tack. |
| Water resistance | Whitening opaque disappeared in 20 minutes. | Very slight whitening disappeared in 20 minutts. | | Opaque whitening disappeared after one hour. |
| Alkali resistance | Film dissolved in 10 minutes. | Film intact for 15 minutes; it swells, and is loosened after 25 minutes. | | Film dissolves in 5 minutes. |
| Solvent resistance | Film swells; swelling medium. | Swelling heavy; peeled off. | | Film partially dissolved. |

T.D.=Touch dry; C.D.=Complete dry.

## Discussion:

It has been stated by Dole and Keskar (7) that substituted sulphonic acids are good catalysts and many of them are superior to sulphuric acid. Benzene sulphonic acid is a strong acid. Only 0.3% of the catalyst is enough for dehydration. The side reactions also take place to a considerable extent. The sample has dark colour which may be due to the oxidation of decomposition products. The third fraction mainly comprises of free fatty acids, partially hydrolysed glycerides, undehydrated castor oil, etc. The first and second fractions show very little after-tack. The film of the third fraction does not dry for a long time and shows poor film properties as compared to the films of first and second fractions. The catalyst is equally active under reduced pressure. Polymerisation of oil at reduced pressure shows that dehydration is achieved to the same extent as that at atmospheric pressure. The side reactions such as, hydrolysis and decomposition are less as compared to the sample at atmospheric pressure, which help in increasing the solubility temperature. First and second fraction films have better film properties than the corresponding fractions at atmospheric pressure.

Anthraquinone 1 : 8 disulphonic acid is a comparatively better active dehydrating agent than benzene sulphonic acid, since only 0.2% of the catalyst is enough for complete dehydration. It develops more unsaturation as compared with benzene sulphonic acid. Anthraquinone being an isomerising catalyst, the above catalyst may be isomerising the dehydrated castor oil with the result that the first and second fraction films dry soon and possess very good resistance towards water and alkali. 'Instantaneous' catalyst is very active and dehydrates the oil within 6 minutes only, giving maximum unsaturation as compared with other catalysts so far investigated. In this case, other side reactions than polymerisation are checked to a greater extent. Films obtained from the first and second fractions dry rapidly to tack-free films with very good film properties, comparing favourably with films of tung oil and superior to linseed oil films.

The solubility temperature of the sample roughly indicates the extent of side reactions. Polymerisation in D. C. O. increases the solubility temperature. Hydrolysis and decomposition lower it. It can be seen from the results that first fraction consists of polymerised D. C. O. having low acid value, low hydroxyl value, and deep colour. The films obtained from this fraction are quick drying, tack-free and have very good water and alkali resistance. The second fraction consists of monomeric D. C. O. in the case of sample obtained by dehydration with anthraquinone 1 : 8 disulphonic acid as catalyst, while in other cases it is semipolymerised D. C. O. The films are rather slow in drying, do not exhibit after-tack, and possess very good film properties. The third fraction is a mixture of undehydrated castor oil, free fatty acids, partially hydrolysed glycerides, decomposition products, etc. Hence it does not dry for a long time. This fraction may be used in preparation of varnishes or alkyds where the defects are masked during the condensation. The first and second fraction may be used in paints as vehicles. If the first and second fractions are mixed and its film properties are studied for after-tack, the film is found to give slight but definite after-tack. It can, therefore, be concluded that after-tack is also due to the presence of species of glycerides possessing different molecular weights, as suggested by H. S. Lilley and R. J. Carter (6).

Thus the after-tack in dehydrated castor oil may be due to :—

(1) Incomplete dehydration.

(2) Hydrolysed and decomposition products.

(3) Presence of many species of glycerides possessing different molecular weights and possessing different rates of uptake of oxygen.

The proper choice of catalyst and careful manipulation of dehydration process would minimise the first two causes and solvent segregation of raw D.C.O. will improve the oil by removing undesirable products and will yield a tack-free fraction of dehydrated castor oil.

**Summary :**

(1) 'Instantaneous' catalyst and anthraquinone 1 : 8 disulphonic acid are better dehydrating agents than benzene sulphonic acid.

(2) Occurrence of side reactions such as, polymerisation, hydrolysis, isomerisation, decomposition, and estolide formation, produce different species of glycerides in raw D. C. O. and cause after-tack effect. (Lilley and Carter(6),).

(3) Side reactions are checked to a greater extent by proper choice of the catalyst and manipulation of dehydration process.

(4) The species of glycerides having different molecular weights can be segregated into separate fractions by fractionation with iso-propyl alcohol and after-tack eliminated by removing undesirable products.

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# DEHYDRATION OF CASTOR OIL WITH "BENZENE-TRI-SULPHONIC ACID" AS CATALYST

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The dehydration of Castor oil is achieved by a large number of catalysts belonging to different groups. Amongst the substances investigated in our laboratory, Sulphonic acids and their derivatives are found to be useful dehydrating catalysts. The use of some monosulphonic acids, as dehydrating catalysts is reported by Dole and Keskar.(1) They studied the effect of substitution of different groups in the benzene ring on the catalytic activity. Rajadhyaksha (2) studied the use of some di-sulphonic acids as catalysts for the dehydration. Di-sulphonic acids show an enhanced activity due to the presence of two sulphonic acid groups. Benzene-m di-sulphonic acid is reported by Dole to be a more effective and powerful catalyst for dehydration than sodium-bi-sulphate, sulphuric acid or benzene-mono-sulphonic acid.(3)

It is observed that phenol-sulphonic-acids mitigate the decomposing tendency of the catalyst without much affecting the dehydrating capacity. Phosphoric acid, although active as a catalyst at a higher temperature (280°C) gives pale coloured dehydrated samples with low acid values. This may be due to the anti-oxident properties of phosphoric acid.(4.5) The sample of D. C. O. obtained by using phosporic acid as a catalyst under vacuum, is very pale in colour and low in acid value. Anthraquinone-di-sulphonic acids are active catalysts, and produce samples of D.C.O. possessing higher percentages of conjugation. Dole and Keskar (6) have reported the production of "high iodine value" D.C.O. with one of the catalysts. The high iodine value exhibited by the D.C.O., was also accompanied by polymerization.

In the present paper, the study of benzene-trisulphonic acid (1 : 3 : 5), as a catalyst for dehydration of castor oil is outlined.

**Experimental :**

The physical and chemical characteristics of the castor oil employed for dehydration are given below:

Iodine value (Wijs, 28°C, 30 minutes) = 84.0
Iodine value (Wöburn; 28°C, 60 minutes) = 88.5
Hydroxyl value = 168.2
Acid Value = 2.1
Sap. value = 184.4
Refractive Index @ 40°C. = 1.4620

The dehydration of castor oil is carried out under two different sets of conditions.

(i) Dehydration under atmospheric pressure, and
(ii) Dehydration under reduced pressure.

(i) **Dehydration under atmospheric pressure: (713 mms.).**

100 g. of castor oil were taken in a wide mouth flat-bottom flask of 500 ml. capacity. The exact quantity of the catalyst (mentioned in individual experiments) is weighed and mixed with the oil. The mixture is stirred by a glass stirrer and a thermometer is suspended in the oil, so that the temperature of dehydration can be observed. The temperature variations were + or — 5°C. After dehydration the sample is cooled in carbon dioxide atmosphere and its different characteristics are determined.

**Rate of dehydration of castor oil :**

Castor oil together with definite quantity of the catalyst is heated as described above. Samples are taken out at intervals of five minutes each. They are immediately cooled. Then the increase in the unsaturation was noted by determining the iodine values of the individual samples.

(ii) **Dehydration under reduced pressures (20 mm. of mercury).**

100 g. of castor oil mixed with the appropriate quantity of the catalyst is taken in a one litre flask (pyrex). It is fitted with a rubber bung with two holes — one for the thermometer and the other for the delivery tube. The delivery tube is connected with a reflux condenser, a flask, a calcium-chloride tower and through a mercury manometer to a vacuum pump.

After tnhe reaction temperature is reached, the flame is adjusted so as to maintain it within + or — 5°C. After the reaction, the D.C.O. is cooled in vacuum. The sample is then analysed for its different characteristic values.

The following characteristic values of the dehydrated samples are determined.

(i) Iodine value (wöburn) (2) Hydroxyl value (Pyridine, acetic anhydride) (3) Acid value, (4) Refractive index at 40°C. (5) Molecular weight by cryoscapic method (Thiophene-free benzene as the solvent), (6) Saponification value, (7) Colour by Lovibend tintometer (Depth of the cell=10 mm.)

**Results :**

### TABLE I.

**Rate of Dehydration of Castor oil**

Catalyst : Benzene-tri-sulphonic acid
Temp. of reaction = 210°c. ± 5°C.
Pressure = 713 mm.

| Concentration of the catalyst | 0.05 percent | 0.1 percent |
|---|---|---|
| Time (Minutes) | Iodine values (Wöburn) | |
| 5 | 107.0 | 118.2 |
| 10 | 108.6 | 130.2 |
| 15 | 113.9 | 142.8 |
| 20 | 121.1 | 149.1 |
| 25 | 125.2 | 153.1 |
| 30 | 133.9 | 154.2 |

## TABLE II

Physical and chemical constants of the D.C.O. Samples.

Time = 30 minutes.
Temp = 210°c ± 5°C.
Pressure = 713 m.m.

| Concentration of the catalyst. | | 0.05 per cent | 0.1 per cent |
|---|---|---|---|
| Iodine value (Wöburn) | | 133.9 | 154.2 |
| Acid value | | 13.5 | 17.3 |
| Mol. weight (Cryoscopic.) | | 983.5 | 1035.0 |
| Saponification value | | 189.4 | 193.2 |
| Refractive Index @ 40°C. | | 1.4770 | 1.4795 |
| Colour Lovibond 10 mm. cell. | B | — | 1.0 |
| | R | — | 9.6 |
| | Y | — | 13.0 |

## TABLE III

Comparison of the rates of dehydration with benzene-mono-di -and tri-sulphonic acids.

| Catalyst | Benzene mono sulphonic acid | Benzene-m-di sulphonic acid. | Benzene tri - sulphonic acid (1 : 3: 5) |
|---|---|---|---|
| No. of $SO_3H$ groups | One | Two | Three |
| Concentration | 0.2% | 0.1% | 0.1% |
| Temperature | 250°C. ± 5°C. | 250 C. ± 5°C. | 210 C. + 5 C |
| Pressure | 713 mm. | 713 mm. | 713 mm. |
| Time (Minutes) | Iodine values (Wöburn) | | |
| 5 | — | — | 118.2 |
| 10 | 110.1 | 128.3 | 130.2 |
| 15 | — | — | 142.8 |
| 20 | 111.3 | 145.4 | 149.1 |
| 25 | — | — | 153.1 |
| 30 | 124.6 | 151.0 | — |
| 40 | 130.3 | 153.1 | — |
| 50 | 135.4 | 155.4 | — |

## TABLE IV

| Catalyst. | | Benzene mono sulphonic acid. | Benzene - m - di sulphonic acid. | Benzene trisulphonic acid. (1: 3: 5) |
|---|---|---|---|---|
| Concentration | | 0.3% | 0.1% | 0.1% |
| Temperature | | 250°C. ± 5°C. | 250°C. ± 5°C. | 210°C. ± 5°C. |
| Time | | 60 minutes | 50 minutes | 30 minutes |
| Pressure | | 713 mm. | 713 mm. | 713 mm. |
| Iodine value (wöburn) | | 147.3 | 155.4 | 154.2 |
| Hydroxyl value | | 51.6 | 31.8 | — |
| Acid value | | 37.0 | 17.5 | 21.3 |
| Saponification value. | | 191.0 | 196.8 | 193.2 |
| Molecular weight (Cryoscopic) | | 938.0 | 928.0 | — |
| Refractive Index @ 40°C. | | 1.4785 | 1.4790 | 1.4795 |
| Colour Lovibond 10 mm. Cell. | B | 9.0 | 1.0 | 1.0 |
| | R | 15.0 | 6.0 | 9.6 |
| | Y | 12.0 | 16.0 | 13.0 |

Benzene tri-sulphonic acid is quite active at a lower temperature (210°C). The concentration of the catalyst required for dehydration is also low. The iodine value (wöburn) of the sample is 154.2. The time of dehydration is also less (30 minutes).

## TABLE V.

Physical and chemical characteristics of the D.C.O. samples prepared with benzene mono-di—and tri-sulphonic acids.

| Catalyst | | Benzene mono sulphonic acid. | Benzene m-di-sulphonic acid. | Benzene-tri-sulphonic acid. (1 : 3 : 5) |
|---|---|---|---|---|
| Concentration | | 0.3% | 0.1% | 0.1% |
| Temperature | | 220°C. ± 5°C. | 250°C. ± 5°C. | 210°C. ± 5°C. |
| Time | | 90 minutes | 50 minutes | 30 minutes. |
| Pressure | | 20 mm. | 20 m.m. | 20 m.m. |
| Iodine value (Wöburn) | | 130.0 | 154.1 | 152.6 |
| Hydroxyl value | | 61.0 | 27.8 | — |
| Acid value | | 8.3 | 9.8 | 10.0 |
| Saponification value | | — | 195.4 | 190.6 |
| Molecular weight (cryoscopic) | | 947.0 | 1008.0 | 1054.0 |
| Refractive Index @ 40°C. | | 1.4732 | 1.4785 | 1.4785 |
| Colour Lovibond 10 mm. cell. | B | 0.0 | 2.0 | 1.0 |
| | R | 1.3 | 1.5 | 7.0 |
| | Y | 4.0 | 14.0 | 18.0 |

The above results show that benzene-tri-sulphonic acid is reactive under reduced pressure as well.

**Solvent Fractionation :**

The D.C.O. prepared with benzene-tri-sulphonic acid was fractionated with isopropyl alcohol.

It is well known that the raw D.C.O. is essentially a mixture of polymerised product, unsaturated glycerides, oxidised and unoxidised decomposition products, free fatty acids, etc. It is concluded by Ambekar (7) that the free fatty acids, estolides and undehydrated oil impart after-tack to the D.C.O. This after-tack in D.C.O. is responsible for its limited use as a paint vehicle in various paint and varnish formulations. The method of solvent fractionation was studied in order to improve the quality, and eliminate the after-tack in D.C.O.

The raw D.C.O. was treated with four times its weight of isopropyl alcohol and the mixture heated in a water-bath to determine "the solubility temperature". At this temperature the D.C.O. becomes completely miscible and gives a clear solution. This solubility temperature differed with different samples of D.C.O. produced by different methods and catalysts. The solubility temperature of the D.C.O. under study was 39°C. The first fraction was separated at 29°C., i.e., ten degrees below the solubility temperature. The second fraction was separated at —10°C., and the third fraction remained in the solvent. The solvent was recovered from the fractions by distillation. The fractions were analysed after removing the last traces of the solvent.

In Tables VI and VII, results of the fractionation of two D.C.O. samples —one prepared under atmospheric pressure (713 mm) and the other prepared under reduced pressure (20 mm)—are given.

**TABLE VI**

**Fractionation of D.C.O. prepared under atmospheric pressure. (713 mm).**

Catalyst 1 : 3 : 5 Benzene-tri-sulphonic acid.

Concentration = 0.1 percent.

Temperature of dehydration = 200°C. ± 5°C.

Time of reaction = 30 minutes.

Solubility temperature = 39°C.

| | | D.C.O. | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|---|
| Temp. | | — | 29°C. | 29°C. to — 10°C. | At – 10°C. |
| Yield | | — | 21.1% | 41.8% | 37.1% |
| Iodine Value (Wöburn) | | 145.2 | 145.0 | 145.4 | 144.1 |
| Hydroxyl Value | | 34.3 | 17.9 | 16.0 | 63.3 |
| Acid value | | 19.0 | 6.5 | 6.4 | 40.2 |
| Sap. value | | 183.4 | 183.2 | 180.7 | 186.3 |
| Molecular weight (cryoscopic) | | 987.2 | 1263.0 | 1088.0 | 786.8 |
| Refractive Index @ 40°C. | | 1.4770 | 1.4780 | 1.4785 | 1.4745 |
| Colour Lovibond 10 mm. cell. | B | 0.0 | 0.0 | 1.0 | 1.0 |
| | R | 9.0 | 10.0 | 6.0 | 5.0 |
| | Y | 18.0 | 18.0 | 18.0 | 18.0 |

## TABLE VII

**Fractionation of D.C.O. prepared under reduced pressure (20 mm.)**
**Catalyst 1 : 3 : 5, Benzene-tri-sulphonic acid.**
**Temperature = 210°C+5°C. Concentration = 0.1 per cent.**
**Time = 30 minutes. Solubility Temp. = 55°C.**

| | | D.C.O. | Fraction I | Fraction II | Fraction III |
|---|---|---|---|---|---|
| Temperature | | — | 45°C. | 54°C. to —10°C. | At – 10°C. |
| Yield | | — | 32.0% | 38.9% | 29.1% |
| Iodine value (Wöburn) | | 152.6 | 150.5 | 152.9 | 154.3 |
| Hydroxyl Value | | 20.4 | 12.3 | 14.8 | 36.5 |
| Acid value | | 10.0 | 2.9 | 2.9 | 24.9 |
| Sap. Value | | 186.9 | 186.0 | 187.2 | 186.6 |
| Molecular Weight (cryoscopic) | | 1054.0 | 1080.0 | 1080.0 | 801.5 |
| Refractive Index @ 40°C. | | 1.4785 | 1.4795 | 1.4790 | 1.4750 |
| Colour Lovibond 10 mm. cell | B | 1.0 | 1.0 | 0.0 | 0.0 |
| | R | 7.0 | 5.0 | 3.0 | 4.2 |
| | Y | 18.0 | 18.0 | 18.0 | 18.0 |

The values in Tables VI and VII indicate that the third fraction contains undehydrated castor oil (if any), decomposition products, free fatty acids. mono and diglycerides. This is supported by the fact that the film of the third fraction remains permanently tacky indicating the presence of non-drying products stated above.(7) The first fraction contains almost polymerised D.C.O.

**Discussion :**

Benzene-tri-sulphonic acid is a powerful dehydrating catalyst. It appears that on account of the three sulphonic acid groups present in it, the substance might be dehydrating cator oil much more rapidly, and at a lower temperature than either benzene-mono sulphonic acid or benzene-m-di-sulphonic acid.

Benzene-tri-sulphonic acid is also equally active under reduced pressure. The D.C.O. obtained under reduced pressure possesses pale colour and low acid number.

**Solvent Fractionation :**

The D.C.O. obtained with benzene-tri-sulphonic acid as the catalyst, can be fractionated with isoproponol. The solubility temperature of the D.C.O prepared at 713 mm. pressure is 39°C. and that of the one prepared at 20 mm. pressure is 55°C. The lower solubility temperature of the former can be explained as due to hydrolysis and incomplete dehydration (revealed by the acid and iodine values). The higher solubility temperature of the latter sampe is due to polymerisation of D.C.O. to some extent and less of hydrolysis of the oil. The yield of the first fraction has increased from 21.1 percent in the former case to 32 per cent in the latter case, which supports the observed high solubility temperature.

The following table gives the solubility temperatures of the D.C.O samples prepared with benzene-mono-di- and tri-sulphonic acids.

TABLE VIII.

| | Percent Catalyst | Catalyst | Temp. and time of dehydration. | Solubility temperature | |
|---|---|---|---|---|---|
| | | | | 713 mm. | 20 mm. |
| 1. | 0.3 | Benzene-S.A. | 250°C. 60 Minutes | 43.5°C. | 45°C. |
| 2. | 0.1 | Benzene-m-di S.A. | 250°C, 60 ,, | 40.0°C. | 47°C. |
| 3. | 0.1 | Benzene-tri-S.A. (1, 3, 5) | 200°C, 30 ,, | 39.0°C. | 55°C. |

Table IX

| | Catalyst | Iodine value (Wöburn) | Acid Value | Solubility temperature. |
|---|---|---|---|---|
| 1. | Benzene mono S.A. | 141.7 | 17.2 | 43.5°C. |
| 2. | Benzene m-di-S.A. | 154.4 | 39.9 | 40.0°C |
| 3. | Benzene tri-S.A. | 145.2 | 19.0 | 39.0°C. |

From the above results, it can be seen that the solubility temperature in the case of benzene sulphonic acid is 43.5°C., while that in the case of benzene-m-di-sulphonic acid is less by 3.5 degrees, although the dehydration of the castor oil is more (Iodine value = 154.4). The low solubility temperature is due to the hydrolysis as revealed by the high acid number.

**Summary :**

(1) Benzene-tri-sulphonic acid is a very active catalyst for the dehydration of castor oil. The percentage of the catalyst required for bringing about dehydration of castor oil is lower than that required with the usual catalysts namely, mono-sulphonic acids, salts of phenol-sulphonic acids, sodium-bi-sulphate, etc. The temperature of dehydration and the duration are also comparatively low as compared with those usually required in the case of mono- and di-sulphonic acids.

(2) Benzene-tri-sulphonic acid is equally active under reduced pressure.

(3) The dehydrated sample obtained under reduced pressure is pale in colour and low in acid number.

(4) Solvent fractionation of the D.C.O. gave three fractions.

The first and second fractions consists of polymerised D.C.O. and pure dehydrated tri-glyceride with some semipolymerised D.C.O. The third fraction consists of hydrolysed and decomposition products.

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## SYNTHETIC PHENOLIC OILS
## CONDENSATION OF PHENOLS WITH LINSEED OIL

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**Phenol, resorcinol, m-cresol and catechol have been condensed with linseed oil in presence of 3% phospheric acid at 200°C. and their reactivities have been compared.**

Eckey (1) has stated that various studies of the condensation of phenols with ethylene and other lower molecular weight olefines have been made, but the reaction of phenols with unsaturated fats and fatty derivatives has been explored to a relatively small extent. The reaction of phenol with linseed oil in presence of various acid catalysts at different temperatures has been studied by Mehta and Doshi (2). In continuation of this work, Mehta, Rao, Rishi and Mulik (3) have shown that in a conjugated oil such as tung oil, the condensation of resorcinol and m-cresol takes place to the extent of 15 and 18% respectively. In the present work, phenol, resorcinol, m-cresol and catechol have been reacted with linseed oil in the presence of phosphoric acid to study the reactivity of these phenols.

### Experimental:

Refined and dried linseed oil of saponification value. 194.0, acid value 0.49 and iodine value (Wijs) 179 was condensed with phenols in presence of 3% Phosphoric acid (92% and sp. gr. 1.75.) The phenols used for condensing were phenol — B. P. 182°C. M. P. 41°C., resorcianol — M. P. 109.8°C., m-cresol B. P. 201°C. and catechol — M. P. 104°C. The reactions were carried out in round-bottomed flasks with ground glass air condensers. The procedure used for condensation was exactly the same as that used in the previous work (3), with the difference that the reaction here is carried out at 200°C., in an oil bath, for four hours. The amounts of m-cresol condensed by reacting different percentages of m-cresol. with linseed oil have been given in Table I and amounts of phenols, resorcinol, m-cresol and catechol condensed by reacting 50% phenols with linseed oil have been shown in Table II. The saponification value of the product was determined by using bromophenol blue and the neutralization value of the hydrolysed phenolic oil by thymol blue as indicators.

### Discussion :

Phenol condensed on the weight of oil is higher than what reacts with the fatty acids. This is because phenol reacted with oil includes phenol that is reacted at the ethylenic linkage as well as the ester group. From the results in Table I the various quantities of phenol added at the double bonds and ester groups can be calculated. It is also found that the percentage of phenol added at the ethylenic linkage is more than what is added at the ester group.

On comparing the figures in Table II it is seen that the activities of the different phenols are not the same. In the case of monohydric phenols the reactivity of m-cresol is greater than that of phenol because of the presence of $CH_3$- group in the m-cresol, while in the case of di-hydric phenols, catechol is more reactive than resorcinol due to the ortho position of the OH-group.

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## TABLE I.

### Condensation of m-cresol with linseed oil.

| m-cresol % | Saponification equivalent. | m-cresol condensed per 100 gms. of oil % | Neutralisation equivalent. | m-cresol condensed per 100 gms. of fatty acids. % | OH-value. | % m-cresol Condensed calculated from OH-value. | % m-cresol Condensed calculated from Neut. value. |
|---|---|---|---|---|---|---|---|
| Blank | 289.8 | — | 271.2 | — | — | — | — |
| 10 | 314.4 | 8.5 | 288.5 | 6.4 | 31.2 | 5.6 | 6.4 |
| 20 | 331.6 | 14.4 | 298.4 | 10.0 | 48.6 | 9.4 | 10.0 |
| 30 | 341.9 | 17.6 | 307.5 | 13.4 | 67.5 | 12.9 | 13.4 |
| 40 | 347.6 | 19.9 | 312.2 | 15.1 | 83.7 | 16.1 | 15.1 |
| 50 | 354.8 | 22.4 | 320.0 | 18.0 | 97.6 | 18.8 | 18.0 |

## TABLE II.

### Condensation of 50% phenols with linseed oil.

| Phenols | Saponification equivalent. | % phenol condensed per 100 gms. of oil. | Neutralisation equivalent. | % phenol condensed per 100 gms. of fatty acids. | OH-value. | % phenol condensed calculated from OH-value. | % phenol condensed calculated from Neut. value. |
|---|---|---|---|---|---|---|---|
| Phenol | 342.7 | 18.3 | 308.8 | 13.9 | 73.0 | 12.2 | 13.9 |
| Resorcinol | 346.3 | 19.1 | 314.9 | 15.7 | 143.2 | 14.0 | 15.7 |
| m-Cresol | 344.9 | 22.5 | 320.0 | 18.0 | 97.6 | 18.8 | 18.8 |
| Catechol | — | — | 332.1 | 18.8 | 191.2 | 18.8 | 18.8 |

# GOKHRU (XANTHIUM-STRUMARIUM) SEED OIL AS A RAW MATERIAL IN SURFACE COATING INDUSTRY

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**Gokhru seed oil was examined spectrophotometrically and found to contain Linoleic acid 53.3%, oleic acid 32% and saturated acids 14.7%. Linseed, Safflower and Gokhru seed oils were polymerized at 300°C. and their bodying rate constants were calculated. Pale boiled and white lead paints from unisomerized and isomerized gokhru seed oil were prepared and their films were compared with those obtained from similar products of linseed and safflower oils. It is found that pale boiled oils obtained from isomerized gokhru seed oil takes the same time as raw linseed oil for drying. Unlike linseed oil film gokhru seed oil film does not turn yellow on ageing, but it suffers from tackiness. Effect of certain chemicals on the films obtained from different oils have also been studied.**

Gokhru (Xanthium-Strumarium) is a wild plant and grows in abundance in the hotter parts of India. Some work on gokhru seed oil was reported by Shrivastava **et al** (1, 2) and Rao (3). The seed is not known to be used for the extraction of oil, although it is known for its medicinal use (4, 5, 6).

Gokhru seed oil belongs to the semi drying group with an iodine value (Wijs) of 122. The composition of the gokhru seed oil was studied by Rao and Kabra (7). Further, the oil was examined spectrophotometrically and the results are given below :—

(180/60 min.) at 234 $m\mu$, $482.5 = 483$
(170/15 min.) at 268 $m\mu$, $2.5 =$ (Neglected)

Whence :

Linoleic acid – 53.3%
Oleic acid – 32.0%
Saturated acids – 14.7%

The "E" values on unisomerized oil were negative.

The present investigation was carried out to find out the possible use of the oil in paint, varnish and surface coating industry as the oil happens to be sufficiently rich in 'linoleic acid' content. Pale boiled oils, polymerized oils (stand oils) and white lead paints were prepared from refined gokhru oil, as well as isomerized gokhru oil, using 0.05% of the metallic radical of "Soligen Kobalt", as the drier. The various properties e.g., drying time resistance to water, alkali, etc., and the effect of various common organic solvents, were compared with similar products of linseed and safflower oils.

**Experimental :**

Pale boiled oils were prepared by dissolving "Soligen Kobalt" (0.05% of metallic radical) as usual. Polymerization of linseed, safflower and gokhru seed oils was carried at 300°C. in three - necked flasks under an atmosphere of carbon di-oxide. Bodying rate constant was found out in all the three oils from the results given in Table II. All the three oils were isomerized according to the original method of Falkenburg and co-workers (8) by heating the oil at 270°C. in presence of 2% anthraquinone for 5 hours. Various properties of the isomerised oils are given in Table V. White lead paints from alkali refined as well as isomerized oils were prepared in an "automatic muller". Their properties are recorded in Tables III and V. Uniform films of different products were coated on ground glass plates with the help of a "Gardner Knife". Drying times of various products were recorded by the Gardner's Automatic Electric Drying Time Recorder. Washability of the paint films was tested in a "Gardner straight line washability and abrasion machine" using water. "Gardner Tube Viscometer was used to measure the viscosities of all the samples of polymerized oils. Other tests such as effect of water, alkali, acid and organic solvents were carried out in the usual manner. The results of the tests are given in Tables IV and VI.

**Discussion :**

A characteristic feature of the gokhru oil film was that when the plate coated with the film (dried for 24 hours) was kept immersed in water for 24 hours, it whitened or blushed temporarily, but regained its original colour and clarity when the water was dried. On the other hand, similar effect of water on linseed oil film was that it blushed badly and permanently. Another important property of the gokhru oil film is its high resistance towards washability. It does not turn, yellow on ageing, like the film of linseed oil. Moreover, gokhru oil film was found to have a good clarity. The tests for the various properties are given in Tables IV and V.

However, two drawbacks were found with gokhru oil film. The first one is that being slow drying in nature, it required 16 hours 15 minutes. While the linseed oil film required 11 hours 54 minutes, to become surface dry. The results of these tests are given in Table X. The Second drawback is that the film remains tacky on standing even though the gardner Recorder indicates 'Dry'.

It was found that polymerized gokhru oil was inferior to polymerized linseed oil in view of its drying properties, as the film of the former required

16 hrs. while that of the latter required 10 hrs. to become surface-dry. It was found that the time for surface drying of the isomerized oil film decreased from 16 hrs. to 11 hrs. 40mins. However, a little tackiness developed in the film on standing. For comparison, safflower and linseed oil were also isomerized by the same process.

It was found that the white lead paint from isomerized linseed oil was completely washed washed off in 1280 strokes. In the case of white lead paint from isomerized safflower oil, there was negligible effect, on 8000 strokes. However, there was no effect on white lead paint from isomerized gokhru oil in 8000 strokes.

## Conclusion :

The properties of the gokhru oil are comparable to those of other drying oils with the solitary exception of its slow drying. It may find its probable use in the preparation of white paints, as well as in the preparation of oil modified alkyd resins, as it does not turn yellow on ageing, but remains flexible and clear over a long period. Taking into account, its high water resistance it can be used in the preparation of moisture and water resistant coatings. Moreover, as the electrical insulating properties of these coatings follow in the same order as the moisture resistant properties offering retardant seals of high dielectric strength (9), the gokhru oil may have its probable use in the preparation of electrical insulating coatings.

In short, gokhru oil seems to have a bright future in the industrial development of the country, and its utilization may contribute to the economic life of the country as it is a "wealth from waste".

The authors thank Dr. M. M Chakrabarty for the spectrophotometric analysis of the oil.

TABLE I.

Alkali refined linseed, gokhru and safflower oil characteristics.

| | Linseed Oil | Safflower oil | Gokhru Oil |
|---|---|---|---|
| Colour by Tintometer (Icm. cell) | | | |
| Yellow | 8 | 6 | 1 |
| Red | 2 | 2 | 0 |
| Sp. gravity at 27°C. | 0.9283 | — | 0.9097 |
| Viscosity at 27°C. (in stokes) | 0.5 | 0.5 | 0.5 |
| Refractive Index at 30°C. | 1.4813 | 1.4763 | 1.4753 |
| Iodine value (Wijs) | 180.0 | 144 | 122.2 |
| Saponification value | 192.0 | 191.0 | 192.0 |

## TABLE II.

### Polymerization of the oils at 300°C.

| Sample No. | Time in minutes | Linseed Oil |  |  | Safflower Oil |  |  | Gokhru seed Oil. |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Viscosity in poises, (27°C) | Log. viscosity | Iodine value (Wijs) | Viscosity in poises. | Log viscosity. | Iodine-value (Wijs) | Viscosity in poises | Log Viscosity | Iodine value (Wijs) |
| 1. | 0 | 0.50 | 1.6990 | 150.3 | 0.51 | 1.7076 | 137.7 | 0.52 | $\bar{1}.7160$ | 121.45 |
| 2. | 30 | 1.12 | 0.0492 | — | 0.62 | 1.7924 | 137.4 | 0.55 | $\bar{1}.7404$ | — |
| 3. | 60 | 2.45 | 0.3892 | 121.1 | 0.75 | $\bar{1}.8751$ | 136.7 | 0.55 | $\bar{1}.7404$ | 118.6 |
| 4. | 90 | 5.40 | 0.7324 | — | 0.95 | 1.9777 | 129.6 | 0.755 | $\bar{1}.8779$ | — |
| 5. | 120 | 8.00 | 0.9031 | 124.7 | 1.08 | 0.0334 | 128.4 | 0.940 | $\bar{1}.9731$ | 108.5 |
| 6. | 150 | 10.05 | 1.1775 | — | 1.2 | 0.0792 | 127.4 | 1.10 | 0.0414 | — |
| 7. | 180 | 20.05 | 1.3021 | 115.5 | — | — | — | 1.20 | 0.0792 | 105.0 |

From the results the average K for linseed, safflower and gokhura oils is 0.0053, 0.0028 and 0.0019 respectively.

$$K = \frac{(\log V_2 - \log V_1)}{(t_2 - t_1)}$$

Where K is a bodying rate constant, and $V_1$ and $V_2$ are viscosities in poises at times $t_1$ and $t_2$ (in minutes) respectively.

## TABLE III.

### Comparison of gokhru, safflower and linseed oil films (Refined Oil + Drier)

| No. | Property | Gokhru oil | Safflower oil | Linseed oil. |
|---|---|---|---|---|
| 1. | Nature and Colour of films. | Sticks tenaciously and firmly to a tin or glass plate. Remains colourless. | Sticks permanently and tenaciously to a tin or glass plate Remains colourless. | Sticks tenaciously and firmly to a tin or glass plate. Develops slight tinge on ageing. |
| 2. | Clarity. | Good. | Good. | Nil. |
| 3. | Tackiness. | Tackiness developed on standing. | Little tackiness developed on standing. | Almost no tackiness. |
| 4. | Time to become surface dry. | 16 hrs. 16 minutes. | 16 Hrs. 16 minutes. | 11 hrs. 40 minutes. |
| 5. | White lead paint from the oils. | Good gloss. The paint does not turn yellow on ageing. | Good gloss. The paint does not turn yellow on ageing. | Poor gloss. Becomes yellowish on ageing. |
| 6. | Flexibility. | Satisfactory. | Satisfactory. | Satisfactory. |
| 7. | Washability and Abrasion Resistance. | Little effect on paint, after 11210 strokes. | Little effect on paint after 7000 strokes. | Paint is washed in 8208 strokes. |

## TABLE IV

Effect of water, alkali, acid and certain organic solvents on linseed, safflower and gokhru oil films. (Drier added).

| Solvent | Gokhru oil | Safflower oil | Linseed oil. |
|---|---|---|---|
| White spirit. | Nil. | Nil. | Nil |
| Carbon tetrachloride. | Blushed, slightly but temporarily. | Blushed slightly but temporarily. | Nil. |
| Petroleum ether. | Nil. | Nil. | Nil. |
| Mineral turpentine. | Nil. | Nil. | Nil. |
| Chloroform. | Film dissolves slowly. | Film dissolves slowly. | Film dissolves rapidly. |
| Benzene. | Film dissolves slowly. | Film dissolves slowly. | Film dissolves slowly. |
| Acetone. | Film dissolves slowly. | Film dissolves slowly. | Film comes off slowly. |
| Water for 24 hours. | Blushed temporarily but regained its original colour and lustre on drying. | Blushed temporarily but regained its original colour on drying. | Blushed badly and permanently. |
| 10% $H_2SO_4$. | No effect. | No effect. | No effect. |
| 5% NaOH. | Film dissolves readily. | Film dissolves readily. | Film dissolves readily. |

## TABLE V.

Comparison of anthraquinone-treated gokhru, safflower and linseed oil films (Drier added)

| No. | Property | Gokhru oil. | Safflower oil. | Linseed oil. |
|---|---|---|---|---|
| 1. | Nature and colour of the film. | Adheres firmly and permanently to a glass or tin panel. Remains colourless. | Adheres firmly and permanently to a glass or tin panel. Remains colourless. | Adheres firmly and permanently to a glass or tin panel. Develops a slight tinge on ageing. |
| 2. | Gloss. | Good glossy film. | Good glossy film. | Gloss poor. |
| 3. | Tackiness. | Film becomes a little tacky on standing. | Little tackiness developed on standing. | Almost nil. |
| 4. | Time to become surface dry. | 11 hrs. 40 minutes. | 7 hrs. 45 minutes. | 3 hrs. 45 minutes. |
| 5. | White lead paint prepared from the oils. | Good gloss and does not turn yellowish on ageing. | Good gloss and does not turn yellow on ageing. | Poor gloss and turns yellowish on ageing. |
| 6. | Flexibility. | Satisfactory. | Satisfactory. | Satisfactory. |
| 7. | Washability and Abrasion resistance. | No effect at all on white lead paint on 8000 strokes. | Negligible effect on white lead paint on 8000 strokes. | Paint washed away completely on 1280 strokes. |

## TABLE VI.

Effect of water, alkali, acid, and certain organic solvents on anthraquinone treated gokhru, safflower and linseed oil films, (Drier added) at 27°C.

| No. | Solvent | Gokhru oil. | Safflower oil. | Linseed oil. |
|---|---|---|---|---|
| 1. | White spirit. | No effect. | No effect. | No effect. |
| 2. | Carbon tetra chloride. | Dissolves slowly. | Dissolves slowly. | No effect. |
| 3. | Petroleum ether. | No effect. | No effect. | No effect. |
| 4. | Chloroform. | Dissolves slowly. | Dissolves slowly. | Dissolves slowly. |
| 5. | Benzene. | Film dissolves rapidly. | Dissolves slowly. | Does not dissolve. |
| 6. | Acetone. | Film dissolves. | Film dissolves. | Film dissolves. |
| 7. | Mineral turpentine. | No effect. | No effect. | No effect. |
| 8. | Water for 24 hrs. | Slightly blushes, but recovers its original gloss and colour soon. | Blushes temporarily but regains its original gloss and colour. | Blushed permanently. |
| 9. | 10% $H_2SO_4$. | No effect. | No. effect. | No effect. |
| 10. | 5% NaOH. | Film removed. | Film removed. | Film removed. |

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# IMPROVEMENT IN THE DRYING PROPERTIES OF LINSEED OIL

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**Various methods for the improvement of the drying properties of linseed oil have been surveyed.**

Although linseed oil is very largely used in the manufacture of surface coatings and is supposed to be an oil par excellence for this purpose, it has certain drawbacks such as a slow drying rate, yellowing tendency, and poor water resistance. Efforts have, therefore, been made since long to improve its drying properties.

## Bodying of linseed oil :

One of the earliest attempts employed to improve the properties of linseed oil consisted in bodying it by heat, oxidation or an electric discharge. The term 'Polymerisation' is loosely applied to chemical changes brought about in the oil in this way. Though the true nature of reactions involved during bodying of linseed oil is not yet clearly understood, a study of the mechanism of reactions suggests that during the first part of the reaction, some of the non-conjugated, unsaturated octa-deca di-and triethenoid acids are isomerised to the conjugated form, which then along with non-conjugated unsaturated acids give polymeric products. There are two types of bodied oils, viz., stand oils and oxidized oils.

## Stand Oils :

These are produced by heating the oil at a high temperature (270°C—300°C), for a certain period of time depending upon the temperature and degree of bodying required. Matiello (1) has given a detailed study of the stand oils produced at various temperatures in presence of air and under vacuum. Many catalysts have been proposed which accelerate the bodying of the oil at high temperatures and there are several patents on the subject (2). The use of catalysts in the manufacture of stand oils has, however, not gained favour in the industry.

## Oxidised Oils :

The effect of oxygen is to introduce active groups into the glyceride structure enabling polymerisation or condensation reactions to take place at much lower temperatures then in the absence of oxygen. These may be divided into two classes (i) Blown oils and (ii) Boiled oils. Blown oils are thickened oils produced by blowing air into them at temperature ranging from 80°C. to 140°C. and for varying lengths of time depending upon the nature and viscosity of products desired. Boiled Oils are produced by heating the oil with or without air blowing in presence of certain driers at varying temperatures. These also have much accelerated drying properties than raw oil and are widely used in surface coatings.

### Electrically bodied oils :

"Voltolizing process" or the bodying of drying oils by an electric discharge was described by Hook and Nottebohm (3) in 1930. The process, however, has not been put to any significant industrial practice, though many devices have since been proposed for the purpose. (4, 5).

Whereas boiled oils have considerably improved drying properties, stand oils possess better durability on out-door exposure. They are commonly used in surface coating industry for the production of decorative paints and varnishes. Blown oils have been developed for cellulose esters, natural resins and oil modified alkyds. The substitution of bodied oil for a part of the raw oil leads to better pigment dispersion.

### Isomerised (or conjugated) linseed oil :

Isomerisation in linseed oil involves the shifting of double bonds in unsaturated di-and trienoic acids from isolated to conjugated positions. Researches on the various methods of isomerisation of linseed oil have for their aim the introduction of maximum degree of conjugation so as to produce an oil approaching tung oil in its drying properties. The main technique of all the processes consists in heating the oil and its fatty acids at elevated temperatures under normal or increased pressure in presence of various catalysts. Chief catalysts suggested from time to time are : alkalies, (6, 7) activated nicked-carbon, (8) silica and other siliceous materials, (9) sulphur dioxide, (10) metals and their oxides, (11) and organic compounds such as tertiary butyl hypochlorite, (12) dedecylamine hydroiodide, triethanolamine hydroiodide, turpentineiodine reaction product, and iodoform, (13) iodine (14) and anthraquinones. (15).

TABLE NO. 1

Isomerised Linseed Oil using Iodine and Anthraquinone as catalysts

| | Sp. Gr. at 30°/30°C. | Ref. Index | Iodine value | Acid Value | Maleic Anhydride Value | Viscosity at 60°C. (Red Wood) seconds | Drying time (in hours) |
|---|---|---|---|---|---|---|---|
| 1. Raw Linseed oil | — | 1.4716 | 177.8 | 2.7 | 3.6 | 113 | 72 |
| 2. Product obtained by boiling under reflux linseed oil with 1% iodine at 200°C. and tolune for 1½ hours. | 0.9274 | 1.4760 | 154.0 | 3.0 | 23.2 | 142 | 26 |
| 3. Products obtained by treating the oil with 5% Anthraquinone at 250°C. for ½ hr. | 0.9296 | 1.4762 | 170.4 | 3.2 | 15.5 | 130 | 18 |

## TABLE NO. 2.

Comparative properties of varnishes prepared with Raw Linseed Oil and Isomerised Linseed Oil.

| No. of Expt. | Varnish from | Time of drying | Nature of film hardness | Elasticity | Resistance to water on immersion for 72 hours | Resistance to acid (2% W/V $H_2SO_4$) | Resistance to mineral oil (kerosene) on 8 hours immersion |
|---|---|---|---|---|---|---|---|
| 1 | Raw linseed Oil | 8 hours | Not very hard | Good | Sweels up, becomes cloudy, soft and detachable on drying in the film is practically white. | As in case of water resistance | Film somewhat soft. |
| 2 | Isomerised linseed oil | 6 hours | Harder and tougher than the above but slightly tacky | Good | Practically no swelling film more or less intact. On drying film somewhat white but not detachable. | As in case of water resistance | Film somewhat soft. |

Work on the preparation of isomerised linseed oil using anthraquinone (16) and iodine (17) has shown that linseed oil when treated with 5% anthraquinone for half an hour at 250°C. produces isomerised oil of good colour and a maleic anhydride value of about 18, and when treated with 1% of iodine, either 200°C for 1½ hour or by heating under reflux with toluence for 3 hours gives isomerised oil of good colour and a maleic anhydride value of about 23. Table No. 1 gives the characteristics of some of the products obtained by the above procedures. Isomerised oils by the above methods gave varnishes with harder and quicker drying films having improved water and acid resistance than those made from raw linseed oil. (Table No. 2)

### Segregation of linseed oil:

Fractionation of an oil into more saturated and more unsaturated fractions is by far one of the most notable advances in the realm of vegetable oils and fats made during the last decade. The various methods used for this purpose are as under :

(1). Solvent segregation or Liquid fractionation.

- i). Furfural process (18)
- ii). Solexol Process (19)

(2). Fractional crystallisation.
(3). Fractional distillation.

Solvent segregation process depends upon the fact that the oil is only partly miscible in the selective solvent, so that on contact two distinct phases seperate, viz.

(1). Solvent predominant phase or the 'extract'.
(2). Oil predominant phase or the 'raffinate.' (20, 21).

The extract is rich in the unsaturated fraction and the raffinate is rich in the saturated fraction. In the Furfural Process continuous counter current methods have been evolved for the segregation of linseed and soya bean oils on an economic scale. Linseed oil gave a fraction of high iodine value (195-205), which was substantiallly a better drying and fast bodying oil having improved alkali resistance, whereas the low iodine value fraction (122-125) was more suited for the production of baking alkyds.(22) A detailed account of the development of the process is given by Kenyon et. al. (23)

In the solexol process liquid propane has been used for the segregation of linseed oil. When oil and liquid propane under pressure are brought into contact at room temperature they are miscible but as the temperature is allowed to approach the critical temperature, the system becomes immiscible and the two phases separate.

Segregation by fractional crystallisation is brought about by crystallisation of the fatty acid mixture from organic solvents at low temperatures. (24), (25) The pioneer researches of Hilditch (26) in this connection are noteworthy. The well-known 'Emersol Process' makes use of 90% methanol which gives easily filtrable crystals at not too low temperatures. Linseed oil fatty acids by this method are reported to give a solid acid fraction of iodine value 87 and a liquid acid fraction of iodine value 195. (27).

Segregation by fractional distillation depends on the difference in the boiling point of the component fatty acids having different chain lengths. As, however, linseed oil is mainly composed of $C_{18}$ acids, the process does not lend itself for application.

**Copolymerisation of linseed oil :**

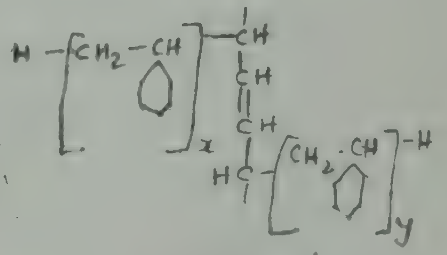
Copolymerisation is one of the most important processes for modifying the drying properties of an oil. It offers immense formulation possibilities and during the last decade or two much work has been published on the subject. Styrene copolymers of drying oils are the most important examples. Hewitt and Armitage (28) showed the possibilities of styrene forming copolymers with blown, heat bodied and isomerised linseed oil, but could not get good results with raw linseed oil. Later researches made it possible to get styrene copolymers with raw linseed oil in presence of certain controlling agents, the most popular being alpha methyl styrene. Kut (29) has made a critical review of the published work on the reactions between styrene and drying oils.

Films of styrenated oils are reported by Hovey (30) to have outstanding hardness, increased drying speed, good water and alkali resistance, good colour and gloss retention, flexibility and exterior durability. The oil may be successfully used in the formulation of baking enamels, floor enamels, rust inhibitive primers, outdoor paints, architectural enamels, amulsion paints, floor and deck paints, printing inks, non-penetrating clear vehicles, ready mixed aluminium vehicles, etc.

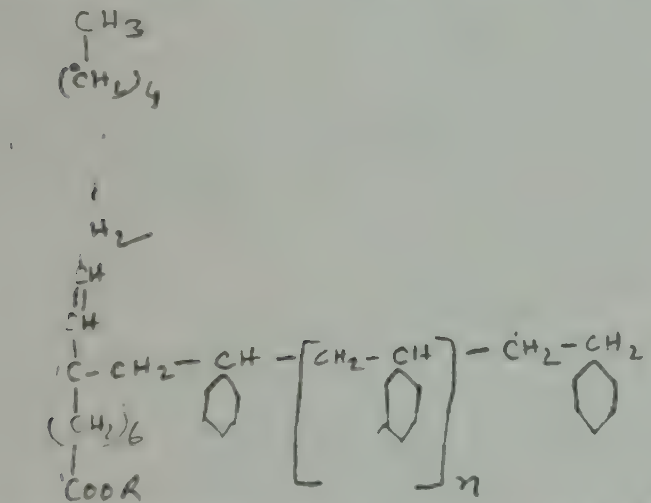
Cyclopentadiene copolymers and copolymers with various other hydrocarbons as butadiene, methylpentadiene etc., have also been used extensively in commerce. Dicyclopentadiene is mixed thoroughly with the oil and heated to about 250°-270°C. when dicyclopentadiene decomposes at about 170°C. to give cyclopentadiene which then reacts with unsaturated fatty acids, to give a modified fatty acid derivative.

These copolymers are easily compatible with other drying oils, can be used in the preparation of oleoresinous varnishes, have excellent alkali and water resistance and give considerably hard films.

Reactions between styrene and unsaturated fatty acid radicals may be represented by the following formulae. (28) :—



Styrene copolymer of conjugated fatty acid radical.



Styrene copolymer of Non-conjugated fatty acid radical.

**Esterification of fatty acids with polyhydric alcohols :**

Esterification of the mixed fatty acids derived from natural drying oils with alcohols having more than three hydroxyl groups per molecule results in the production of drying oils having greater reactivity. Many compounds as erythritol, mannitol, sorbitol, pentaerythritol, inositol and di-pentaerythritol have been studied for the purpose. Gibbon and Gordon (31) made an interesting study of the inositol esters of linseed oil fatty acids. Varnishes prepared from the esters were reported to body and dry more rapidly and to possess excellent water and alkali resistance. However, pentaerythritol is the only one to have industrial application. The esterification of the fatty acid mixture from linseed oil shows only a slight advantage over the parent oil as regards bodying rate, drying time, film hardness, and water resistance as much of the advantage is offset against the development of bloom under certain atmospheric conditions.

**Sulphurised linseed oil :**

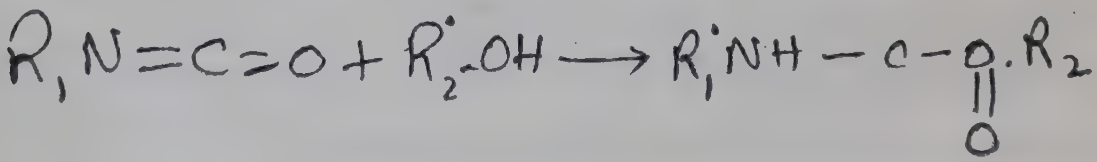
Linseed oil treated with sulphur mono-chloride is reported to possess certain outstanding properties which make its use possible as a cheap medium in paint and varnish formulations. Remarkable attributes reported are rapid-setting films, good rust proofing properties, low water absorption and good durability. However, the process has not found much industrial application owing to storage difficulties due to poor stability of the product.

**Maleic treated linseed oils :**

Recently reactions involving the treatment of non-conjugated drying oils with maleic anhydride at high temperature have aroused much interest. The reaction is carried out by heating the oil with alphabeta unsaturated di-carboxylic acid or its anhydride, in a temperature range of 185-250°C. Many patents have been drawn upon the process (32). Maleic anhydride modified drying oils are reported to possess enhanced drying properties. With non-conjugated oils, as linseed oil, the addition results in an alkenyl succinic acid anhydride. The maleic modified linssed oil can be used to advantage as partial or complete replacement for tung oil in oleo-resinous vehicles.

**Urethane Oils :**

Wartz in 1948 (33) showed the mechanism of the urethane reaction in which an isocyanate is reacted with compounds containing hydroxyl groups whereby the hydrogen is transferred from the hydroxyl group to the nitrogen of the isocyanate. The reaction may be represented as follows.



$$R_1N{=}C{=}O + R_2^{\cdot}\text{-}OH \longrightarrow R_1^{\cdot}NH - C - \underset{\overset{\|}{O}}{O}.R_2$$

Bayer (34) made a significant contribution to the study of this reaction. The reaction may be applied to the modification of drying oils by first forming mono and di-esters by alcoholysis in the usual way followed by reacting it with either mono-or di-isocyanate. Baltes (35) showed the films produced from urethane oils to be comparatively quick drying giving harder films which are water-resistant and possess high tensile strength. Robinson and Waters (36) studied the reaction using mixed glycerides from linseed oils and chlorophenylene di-isocyanate in proportions of 50.70, 100 and 125% of the calculated theoretical quantity from the free hydroxyl content. Prolonged exposure tests carried out showed loss of gloss, cracking of films and poor colour retention. Further work has yet to be carried out before giving any definite evaluation of these oils in surface coatings.

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# GENERAL

# LONG CHAIN HYDROXY AND DICARBOXYLIC ACIDS FROM FATS

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**Long chain hydroxy and dicarboxylic acids have attracted great deal of attention in recent years as they are the starting substances for the syntheses of various perfumery materials. Metallic salts of hydroxy fatty acids have found use in the preparation of lubricating greases. The saturated hydroxy acids are high melting waxes. Long chain dicarboxylic acids are starting materials for the preparation of fibres, plastics and plasticisers.**

**Ricinoleic acid, 12-hydroxy octadeca-9-enoic acid, constitutes 80-90 per cent of castor oil fatty acids and is present in small quantities in some other seed oils. A simple method for the preparation of 12-hydroxystearic acid from it, is described. 9-Hydroxy 12-enoic acid has recently been isolated from the seed oils from strophanthus species. Kamala seed oil has been found to be a very easy source for 18-hydroxy 9, 11, 13-octadecatrienoic acid. This acid has been hydrogenated to 18-hydroxystearic acid, which on oxidation gave hexadecamethylene 1 : 16-dicarboxylic acid. Other dicarboxylic acids which can be easily obtained from fats are sebacic azelaic brassylic acids. Besides uses as mentioned above, their employment in the syntheses of useful compounds is being investigated.**

## Importance and uses :

Long chain hydroxy and dicarboxylic acids have attracted a great deal of attention in recent years because of their varied industrial applications. Before coming to the natural and other sources of production of these acids, their manifold uses will be briefly described to emphasize their importance in industry.

Alkyl ester of ricinoleic, hydroxy stearic and of dibasic acids such as azelaic and sebacic are used as plasticizers in vinyl shower curtains, upholstery materials, rain coats etc. Esters of these dibasic acid are also used as lubricating oils preferably after modification of the molecule by a controlled amount of branching. Such esters to-day are finding use in jet engines and in other machines because of their low pour points, high flash and fire points, excellent viscosity temperature relationship outstanding resistance to oxidation and minimum tendency for corrosion of various metals. The polyesters of dibasic acids find use for coatings and fibers and the polyamides for coatings, fibers and plastics. The Polyamide from dilinoleic acid and ethylene diamine is produced commercially for use in coatings and adhesives. A reaction product of dicarboxylic acid and unsaturated fatty acid alcohol or sulphurized oleic acid is used as an additive in lubricants as rust and corrosion inhibitor. Mixtures of fatty acid amines and dibasic acids find applications as defoamers. Some of synthetic detergents are polymerised derivatives of pyridine containing fatty and dibasic radicals. Amido ester waxes for polishing are condensate products of fatty acid and alkanolamine reacted with dibasic acid. The use of dilinoleic acid as a crystallisation inhibitor for D. D. T. has been recently suggested. Polyglycol ester of dilinoleic acid also finds application as an emulsifier. Higher molecular weight dicarboxylic acids are important starting materials for synthetic products including perfumery materials such as lactones and ketones.

Some surface active agents used as petroleum demulsifiers are amines, diamines, and esters derived from ricinoleic acid. On the other hand quarternery ammonium emulsifiers containing hydroxy-fatty acid radicals have been recommended for casein emulsion paints and in carbon black dispersions. Esters of hydroxy acids and cyclo aliphatic alcohols are bases of any synthetic detergents. Calcium soaps of hydroxy acids are used in greases having high drop point. Lithium-12-hydroxy stearate finds application as a low temperature grease base because it can be compounded with dibasic esters to produce lubricating greases which can function at a temperature as low as —73°C. Aluminium ricinoleate is an ideal water proofing agent for textiles because it forms stable continuous, flexible and transparent films which resist dry-cleaning solvents. Higher saturated hydroxy acids as well as polyesterified hydroxy acids are high melting hard waxy solids.

**Occurrence and production of hydroxy acids :**

Hydroxy acids are not as common amongst the component acids of fats as other straight chain acids though they occur more frequently in waxes and are also known to be present in brain lipids. Almost all the hydroxy acids present in fats contain 18-carbon atoms.

The most important naturally occuring hydroxy acid is ricinoleic acid, 12-hydroxy-9-octadecenoic acid from castor oil where it is present to the extent of 80-90%. A very simple method of isolating the acid from the oil consists in extracting the oil with low boiling petroleum ether (30-60) whence the solvent insoluble fraction constituting about 70% consists wholly of triricinolein from which the ricinoleic acid can be isolated in the usual manner (1).

For the production of 12-hydroxy stearic acid, the triricinolein obtained as above was hydrogenated using supported as well as Raney's Nickel catalyst. The triglyceride was taken in 2.½ time ethyl alcohol, and the requisite amount of catalyst (4% supported Ni, 2-3% Raney Nickel). was added. The hydrogen pressure was maintained at 300-350 lbs. Raney nickel catalyst was found to work more efficiently in as much as the hydrogenation was complete at a lower temperature and in lesser time. Best results were obtained when the initial temperature was kept at about 100°C. for 4 hours and then raised to

150 C. for 3 hours to complete the hydrogenation. The I. V. of the hydrogenated sample was less than 2 which became negligible after one crystalisation of the acid obtained after hydrolysis. The crystallised 12-hydroxy stearic acid had almost theoretical characteristics.

In addition to castor oil there are other less commonly known sources of ricinoleic acid and its isomers. Badhara (**Gmelina Asiatica**) and Mandara (**Jatropha Euphorbiaceae**) seed oils contain ricinoleic acid to the extent of 11% (2) and 12.9% (3) respectively. Argemone oil contains this acid to the extent of 9.84% (4). It has also been reported to be present in ivory wood oil (5) and Agonandra seed fat (6). An isomer of ricinoleic acid-hydroxy-12-octadecenoic acid has been shown to occur in the seed oils of three **strophanthus species** to the extent of 6-13% (7). Hydroxy acid is also reported in seed oil of **Onguekoa Gore** (Engler) (8).

An important source of -hydroxy acid has been found in the oil of kamala seeds which contains kamlolenic acid. 18-hydroxy octadeca-9. 11, 13-trienoic acid the only acid known having a terminal hydroxyl group and a conjugated triene system — to the extent of 60% (9).

Kamlolenic acid had already been reduced to 18-hydroxy-stearic acid by the action of hydrogen in presence of platinum catalyst (10). A practical method for the preparation of 18-hydroxy-stearic acid from this oil has been developed recently in Laboratory. The fatty acids from kamala seed oil extracted with hexane were shaken with low boiling petroleum ether when most of the kamlolenic acid separated as pale coloured solid. It was purified by crystallisation from benzene and/or ethyl acetate. The resulting kamlolenic acid was hydrogenated with Raney's Nickel catalyst (2—3%) at a temperature less than 100°C. in the initial stages which was later allowed to rise to about 120°C. Ethyl alcohol was used as the solvent. The pressure was maintained at 400 lbs. Total time taken to complete the hydrogenation was 7 hrs. The resulting acid after one crystallisation from ethyl acetate melted at 97—98°C.

18-Hydroxy-stearic acid in 12-hydroxy-stearic acid gave corresponding lactones when treated with p-toluene sulphonic acid according to the method of Stoll (11) and of Toyama (12). The maximum yield of the lactone in the former case was 83.9% and in the latter 7.4%.

**Occurrence and production of dibasic acids:**

The lower aliphatic dibasic acids occur more abundantly in nature than the higher members. Among the higher members azelaic acid has been reported to be present in several fatty materials (13), presumably as a result of the oxidative cleavage of some fatty acid having a double bond at the 9th position. Thapsic acid, tetradecamethylene 1 : 14-dicarboxylic acid, is found in the root of **Thapsia garganica.** (14) Even higher molecular weight dibasic acids occur in various plant waxes. The best known source is Japan wax which contains a mixture of normal members of the series $C_{19}$ to $C_{23}$.

The most important of the dibasic acids having commercial applications are azelaic, sebacic, brassylic and dilinoleic acids. Commonly occuring unsaturated fatty acids provide convenient raw materials for the synthesis of all of these dibasic acids. Azelaic acid or heptamethylene 1 : 7 dicraboxylic acid is produced from oleic acid by means of chromic acid or ozone. Both the methods are used commercially. It can also be prepared by oxidation of linoleic and linolenic acids. In a similar way brassylic acid or undecamethylene 1, 11-dicarboxylic acid, is produced by the oxidation of erucic acid, principal acid in many of the seed fats particularly those beloning to the N.O. **Cruciferae.** Rape and mustard oils are important sources of this acid where it is present to the extent of 40-45.% Nasturium oil fatty acids contain 82% of erucic acid.(17) Sebacic acid is produced from ricinoleic acid. Aggarwal et al (18) reported 53% yield of this acid by heating the castor oil soap in presence of 30% caustic soda under steam pressure of 700 lbs./sq. in. Octyl alcohol is the other product of reaction. Dilinoleic acid which is a mixture of a number of cyclic isomers is produced by thermal dimerisation of linoleic acid. Dimerisation at a temperature of the order of 360°C.(19) in presence of small amounts of water under pressure which prevents decarboxylation gives good results. Dilinoleic acid is also the major acid in the depolymerised Product from castor oil gel.(20).

Hexa-decamethylene 1 : 16-dicarboxylic acid has been prepared in excellent yield from 18-hydroxy-stearic acid obtained by the hydrogenation of kamlolenic acid present in kamala seed oil by oxidation with potassium dichromate and sulphuric acid. 70-75 gm. of pottasium dichromate are dissolved in 350 c.c. of dilute sulphuric acid. (1 : 2) 50 gms. of 18-hydroxy-stearic acid are added in small lots during the course of 1.1/2 hours. Warming on a water-bath specially during the initial stages is necessary during addition. The whole mixture is then heated with stirring in an oil bath at 90-95°C. for 4 hours after which the temperature is slowly raised to 120-125°C. and kept at that temperature for about 3 hours. The material then is thrown in water, filtered and washed. The dibasic acid thus obtained has a slight bluish green colour which can be removed by heating with a small amount of dilute sulphuric acid (1 : 1). The washed dried material when crystalised from acetone melted at 123.5°C—124.5°C, yield 89%, mol. wt. 316 (Theoretical 314).

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# SYNTHETIC LEATHER OILS

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Several types of vegetable, marine and mineral oils find application in leather industry. In order to supplement the natural products, synthetic leather oils were developed in Germany during the last world war. They were obtained by chlorination of suitable hydrocarbon fractions obtained from Fischer Tropsch synthesis. With a view to develop these synthetic leather oils and make them available to the Industry economically attempts were made at the Central Leather Research Institute to chlorinate the readily available mineral oil fractions. Kerosene oil, diesel oil, furnace oil and several other fractions obtained from the refineries were chlorinated and the optimum conditions arrived at. Suitable emulsifying agents were developed for making a fat-liquor from these chlorinated oils. The characteristics of the leathers fat-liquored with the different oils have been outlined.

A synthetic oil tanning agent was also developed in Germany by sulpho chlorination of the hydrocarbon fractions. Since in India cod oil is not available and the quality of available fish oil is poor, investigations were undertaken at the Central Leather Research Institute to prepare synthetic oiltan. A detailed study was made with regard to the suitability of raw material, the optimum extent of sulphochlorination and the analysis of the product. It was found that kerosene oil when suitably sulphochlorinated produce a leather which possesses all the properties of chamois leather.

A number of oils and fats of vegetable, marine and mineral origin are used in leather industry. Synthetic oils and fats, however, were first introduced in German Leather Industry during the last world war to supplement the insufficient supply of natural oils.(1) They were made by chlorination and sulphochlorination of hydrocarbons of suitable length.

The development of synthetic leather oils has great potentialities in India in view of the availability of the raw materials which can be economically exploited for their manufacture and the inadequate supply of the traditional leather oils and fats in India.

**Synthetic Leather Oils and Fats prepared by chlorinating hydrocarbons :**

With a view to obtain the basic product which is a chlorinated hydrocarbon, containing 40% chlorine a survey of all the available mineral oil fractions like kerosene oil, treated kerosene oil, several grades of diesel oil, furnace oil and solvent oil were made as regards their suitability for use as raw materials and the results are published in previous communications (2,3 The chlorine contents of the products obtained are given in Table 1. The optimum conditions of chlorination have been experimentally found. Judged by the analysis of chlorine content, several analogues of the German product have been obtained from kerosene oil, power kerosene oil and diesel oil.

The chlorinated oils are immisicible with water and are too light and hence cannot be used as such. However by addition of other ingredients several useful products which are applicable in leather industry have been obtained. Thus by the addition of polymerised vinyl isobutyl ether (commercial names Igevin and Densodrin) or poly ethylene glycol a substitute for Cod or Train oil could be prepared.

In order to make an emulsion of the oil in water so that the leather could be treated with the emulsion by a process known as fat-liquoring, several additive products, have been employed. However, the one obtained from diesel oil by the German process described in BIOS report which is made by sulphochlorination, amidation and condensation with chloroacetic acid to get sulphamidoacetic acid was made in the laboratory and found to be useful for fat-liquoring chrome tanned sides. Experiments have also been carried out on the chlorination of vegetable oils, both edible and non-edible. However it is yet to be proved whether these chlorinated vegetable oils could be used in leather industry.

**Synthetic fat replacement products :**

To substitute fats the chlorinated oils have been mixed with chlorinated paraffin wax and used for stuffing purposes in leather industry. The details of manufacture are given in BIOS report by Das.(1) Excellent fat substitute have been prepared by a modified process. Initially the chlorination of the mineral oils were carried out to a higher degree (45-50%). In addition to treating them with chlorinated paraffin wax, suitable quantities of thickeners like stearic acid were also added. The fat substitutes thus prepared from kerosene oil and diesel oil were found to be as good as the stuffing mixtures prepared out of the usual tallow, fish oil mixture. Experiments are also being carried out to prepare stuffing mixtures from chlorinated vegetable oils.

**Synthetic oil tans :**

The synthetic oil tan known commercially as Immergan was principally used in Germany for the manufacture of chamois leather, glove leather, etc. The preparation and the process of tanning has been exhaustively described by das in his report (loc. cit. p. 746). The process consists in sulphochlorinating suitable hydrocarbon in presence of U.V. light as catalyst.(4) Several mineral oil fractions have been sulphochlorinated under optimum conditions and the products tested for their application in leather industry. The products were analysed for their sulphur and chlorine contents. The raw materials taken for sulphochlorination and the analytical values of the product obtained are given in Table II. The synthetic oil tan which has been prepared from kerosene oil has been used for making chamois leather with satisfactory results. From the data it is seen that the sulphur and chlorine contents of the sulphochlorinated kerosene oil corresponds to the sulphur and chlorine contents of the imported Immergan thus providing a suitable substitute. The keeping qualities of the synthetic oil tans are under investigation. It would be certainly worth while investigating the sulphochlorination of fish and other vegetable oils with a view to use them in leather industry.

This research project will be conducive to the establishment in India of an industry for the manufacture of synthetic oils, fats and allied products which will be of immense utility to the leather industry.

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### Table I

Volume of the oil used = 250 cc.
Rate of chlorination = 8 litres/hour
Duration of chlorination = 15 to 16 hours

| Raw material | Chlorine content % |
|---|---|
| Kerosene oil | 39.9 |
| Diesel oil | 38.8 |
| Furnace oil | 40.0 |
| Power kerosene oil | 38.1 |
| Solvent oil B.P. 60-80°C. | 36.3 |
| Mixture of kerosene and Solvent oil | 38.1 |
| Mixture of power kerosene and solvent oil | 41.5 |
| Kerosene oil (Eldeanau treated) | 31.5 |
| Light virginia diesel oil | 20.8 |
| Virginia heavy diesel oil | 20.3 |

### Table II

Duration of sulphochlorination = 12 hours
Volume of oil taken = 250 cc.
Ratio of $SO_2 : Cl_2$ : : 1 : 1
Rate of passages of gas = 6.7 litres/hour.

| Raw material | S. content % | Cl content % |
|---|---|---|
| Kogasin (Immergan) | 8.4 | 24.2 |
| Power kerosene oil | 5.1 | 25.3 |
| Solvent oil, 60°C. | 12.9 | 26.9 |
| Diesel oil | 5.9 | 28.2 |
| Kerosene oil | 8.1 | 26.8 |

# MARKETING OF VEGETABLE OILS

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Usage of edible oils and fats, like other dietary habits, varies in different regions, the main influences being climate, local availability and distribution facilities. This has led to a traditional pattern which in the case of India broadly resembles that of Europe, the North using mainly hard fat and the South mainly soft oil, with a mixed pattern in between.

The economic effects of the Industrial Revolution in Europe upset the balance of the existing oils and fats market, and demand outran supply. A solution was found in the hydrogenation of imported vegetable oils to make Margarine, a synthetic substitute for natural butter. This innovation in a market based on centuries-old tradition naturally encountered consumer resistance and prejudice which it has taken time and much consumer education to overcome.

The big rise in the population of India since 1938 has increased domestic requirements of oils and fats, and the shortage thus created is likely to be aggravated by current political and economic changes which will increase the standard of living. These conditions have forced up the price of ghee, and the supply position of oils, such as til, mustard and groundnut, traditionally preferred in different regions, has become precarious. Here too hydrogenation can help to fill the gap in the form of vegetable oils, is presented in a form with acceptance all over the country, cutting across regional preferences. Its vitamin content and low price also provide a means of making good a major nutritional deficiency among the less well-to-do.

The future is likely to bring increased demands on the oil resources of India and the quick solution to the problem of short supply seems to lie in growing more groundnut, which can both be converted into vanaspati, and, as an export, earn foreign currency. Resources of cottonseed oil, in itself inedible, can also be exploited by conversion into vanaspati.

As in Europe, there is in India considerable opposition to the substitute product; and future development on the lines suggested depends on acceptance of vanaspati among people of every region as an "all-India fat" as has already been achieved in the case of the Defence Services.

In consideration how to deal with such a large subject as "The Marketing of Vegetable Oils" in 15 minutes, one is faced with a number of alternative lines of approach. In the final analysis however the problems inherent in all aspects of marketing arise from the unique complexity of the vegetable oils market itself. Not only does this market offer an intriguing field of study, it provides the background from which considerations such as distribution, selling and advertising follow naturally. I prepose therefore in this short paper to deal primarily with the market for edible oils what is its structure and how it has developed.

The various food habits of the inhabitants of different parts of the world can be said to be dependent mainly on two factors — climate and distribution. Obviously the type of food eaten in a particular region depends on the conditions of land and climate and their suitability for particular crops. The market for fats and vegetable oils provides a good example. In Europe, for instance, the Northern countries are traditionally big producers and consumers of butter; in the Mediterranean countries — Spain, Italy and Greece — soft oil (mainly olive oil) is the main cooking medium; while in Central Europe both butter and oil are used.

It is natural that the inhabitants of different countries should have turned first to the foodstuffs most readily, available in their own local conditions. This natural tendency was projected into an absolute necessity by the lack of long-range transport facilities in earlier years. And what was origially enforced by circumstances became in the course of time a habit-pattern.

Turning to India, we find a pattern of food habits, including the usage of vegetable oils and fats, which bears a striking similarity to that of Europe. The big ghee-producing regions of North India are also the main areas of hard fat consumption. Moving down to Central India we find usage of both ghee and oil type of oil used depending on local availability. Of the oils generally used in India mustard oil has quite a big following in the North; in the South-West coconut oil is the staple cooking medium; whilst in the rest of the South and in Central India til oil enjoys the greatest popularity. Here too there is no doubt that these variations in eating and cooking habits have developed through a combination of the use of what is locally available and the lack of good inter-regional transport facilities. In the case of a perishable product, such as vegetable oils, the lack of quick, easy distribution facilities have obvious important implications.

To see the development of the vegetable oils market in India in proper perspective, it is probably best to look first at the development of this market in Europe. Not only are the two markets actually inter-connected; the Indian market is following the European market along the same line of development.

The traditional pattern of vegetable oil consumption in Europe — hard fat in the North, oil in the South, and a mixed pattern in between — was stabilised on the basis of a predominantly agricultural population, with supply and demand more or less balanced. Then in the 19th Century the Industrial Revolution upset the balance by drawing a large part of the population away from the land to large towns which depended for their sustenance on the rural areas outside. Demand for butter and oil, like other products of the land, began to outstrip supply, and there was a shortage of the all important edible oils and fats.

The Industrial Revolution however brought the solution to its own problem through the development of faster, better means of transport which brought the West into direct contact with distant parts of the world, such as Africa and India, which could provide ready supplies of the much-needed oils. But these oils, specifically groundnut oil, still had to be presented in an acceptable form to markets with a traditional habit-pattern of consuming olive oil and — most especially — butter. The answer came in the form of hydrogenation, the process by which refined vegetable oils of any kind could be hardened and presented as a synthetic substitute for natural butter — margarine; and over the years the original rather crude attempts to produce butter synthetically have shown marked improvements.

Yet the new margarine had a stuff uphill struggle to gain acceptance. With a centuries-old habit of using natural butter, it was to be expected that people's attitude to a synthetic substitute would generally be one of prejudice. During the early decades of the 20th Century, margarine was held in disrepute, as a product which was only used by the lower-income groups out of economic necessity, since it was cheaper than butter. It took years of consumer education, product improvement, and finally the Second World War to establish margarine in general acceptance. During the war acute shortage and rationing of butter and fats generally in the belligerent countries forced many people to use margarine; and the ground thus gained by margarine has not since been lost.

So we see the balance of supply and demand for oils and fats on a world-market basis redressed by the development of hydrogenation in Europe. But this is not the end of the story.

During the early part of the 20th Century — in fact until the Second World War — India was one of the so-called "under-developed" countries which supplied oilseeds and oils to the margarine manufacturers of Europe. Ghee and vegetable oils, such as sesame, mustard and coconut, were, of course, the accepted cooking media in different parts of the country; but the consumption of fats per head of population was far below that of Western countries. In fact a large surplus of vegetable oils was readily available for export to help supply the deficiencies of the West. During the past 17 years, however, an increase of 100 million in the population of India alone has brought a proportionate increase in domestic requirements of fats and oils. The political and economic developments which have been and still are taking place are also likely to affect the situation by raising the standard of living in India and the other under-developed countries — or at least by making the people of those countries conscious that it can be raised. This would bring about an increase in their present low per capita consumption of oils and fats, especially with the realisation of the vast natural resources ready to hand; resources which were hitherto going to maintain a high level of fat consumption in the West.

As the population and with it demand for fats went up in India, ghee production had difficulty in keeping pace with it, and the price of ghee rose to a level which put it beyond the economic reach of many would-be ghee-users: while many others who did buy ghee could not afford as much as they would have liked. As in the West, the shortage was aggrevated by growing industrialisation in India, drawing a large part of the population away from the land. To fill the gap people turned once more to the process which had saved the situation in the West — hydrogenation. So the vanaspati industry was born in India, to offer to the traditional ghee consumers an inexpensive hard fat substitute; and, to the traditional consumers of particular kinds of vegetable oils, refined oil in a different form.

Hydrogenation, in the form of the vanaspati industry, offers to the edible oils market in India the extra supply and flexibility which are its basic needs. Vanaspati in effect rationalises the oil resources of the country. Groundnut oil is produced in larger quantities and more cheaply than any of the other vegetable oils generally used in India. However, unlike mustard, coconut and til oil, it has no distinctive flavour with intrinsic appeal, and so does not have any specific regional acceptance like these other oils. In fact it is generally regarded as a poor man's oil. Vanaspati however gives it the status of a product which has acceptance all over the country. With its vitamin content and low price it also helps to make good a major nutritional deficiency especially among the less well-to-do.

With a growing population and improving standards of living, the future demands on the oil resources of India are likely to become increasingly greater. The different regions will need more and more of the traditional oils — coconut, mustard, til and kardi. But these oils cannot be produced as readily as groundnut oil. The quick solution to our problem of short supply therefore seems to lie in growing more groundnut. Not only can groundnut oils be converted into vanaspati, in which form it can have acceptance throughout the country; it is also a useful foreign currency earner, since there is a very good international market for groundnut oil. Our growing resources of cottonseed oil — at present left unextracted in the seeds given to cattle — can also be extracted and converted into vanaspati: this is in fact already being done in America.

The further big problem — more of a marketing one — is how quickly and completely can the consumer be educated to acceptance of vanaspati. Here too, as in the West, the battle for recognition and acceptance of the alternative product is a hard one. With centuries of tradition behind it, the same opposition and natural prejudice is there — in fact they are perhaps even stronger than in the West, since natural ghee has an almost ritual association. Inevitably there is reluctance or even refusal to believe that substitute product can have as much nutritional value as its natural equivalent. In time of shortage of ghee, people had to accept vanaspati simply as an economic proposition. However, as ghee production increase, as ghee prices fall, or as more money becomes available for the consumer to spend, there is an immediate trend back to the traditional natural fat.

So that is the position of the vegetable oils market today — one of potential balance (with the help of hydrogenation) but of actual shortage, owing to the factors just outlined. What future development and progress — can be expected? This, like anything depending on consumer psychology and attitudes, must carry a question mark, but what has happened in the Defence Services may give some indication. The Army is gradually developing men of different racial groups into what may be called an all-India type, and their different racial characteristics are becoming less and less marked. In particular, and for obvious practical reasons, a food-habit pattern common to them all has had to be evolved. Oils and fats are one of the basic factors in diet; and five years ago, after considerable investigation and research, the Army adopted vanaspati as the one type of fat which could gain ready acceptance among men of every region. Perhaps this is the first stage in a development which may in a few years extend throughout India as she evolves into a homogeneous, united nation.

# INSECT PESTS OF COPRA AND THEIR CONTROL

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1. Insects cause serious damage to copra in storage. In addition to the direct loss in tonnage, the quality of copra also deteriorates on account of a considerable increase in the free fatty acids due to insect action. . . . .

2. The important insect pests noticed in copra stores and mills in South India are "Necrobia rufipes de Geer." "Oryzaephilus surinamensis L." "Tribolium castaneum Hbst." "Carpophilus dimidiatus F." "Trogoderma granaria Everts," "Ephestia cautella Walk," and "Corcyra cephalonica St." Distinguishing characters and short biological notes of these insects are given in the text.

3. The prevalence of insects in a copra store is intimately connected with the quantity of mouldly degenerated copra.

4. Copra could be kept free from insect attack, if the moisture content of coconut meat is reduced to below 6 per cent by a rapid uniform drying soon after splitting of the nuts, and the bags employed for transportation have rendered insect-free.

5. Preventive measures in copra mills, which include maintenance of strict hygiene, keeping the stores dry and periodic treatment of the structures with DDT or gamma isomer BHC give a fair protection from most of the copra pests.

6. For controlling the insect infestations, fumigation in sealed stores or under the gas-proof tarpaulins with methyl bromide at 1 lb./1000 cu. ft. is suggested.

## Introduction :

It has been estimated that out of the total Indian production of 3,375 million coconuts, 1,579 millions are converted into copra, and the remainder used for edible and seed purposes. The total quantity of copra produced is about 232,000 tons, out of which 21% or about 49,000 tons are retained for edible purposes and the balance is utilised for milling. This quantity of copra yields 113,000 tons of coconut oil which falls short of our present requirements by 40,000 tons. It is estimated that by the end of 1960-61, the deficit will increase to 80,000 tons, on account of increase in population and demand from soap industries, etc. Great efforts are being made in India to meet this shortage. More areas are being put under coconut and the production of nuts from the existing plantations is being stepped up by adopting moder cultural, manurial and plant protection practices. But so far, no attentio appears to have been made to the insects which cause damage to copra i storage.

Apart from losses in tonnage, insect attack adversely affects quality. Th copra that has been infested in storage suffers a considerable increase in fre fatty acid content, due, in the main, to the increased surfaces of the insec riddled nuts becoming exposed to oxidation. In severe cases the financia loss on this account may even exceed that arising from loss by weight. Unde the Agriculture Produce (Grading and Marketing) Act, 1937, the grading o coconut oil in India is mostly based on the presence of free fatty acids.

Copra which arrives at the mill in an infested condition may continue t deteriorate during storage, and not only will actual loss in weight result fron feeding by insects, but the copra may become musty or mouldy and absolutel unsuitable for milling. It would be difficult to produce a satisfactory hig grade oil from badly infested copra.

Assessing the annual loss of copra by insect infestation at five percen only, the quantity of copra damaged every year is more than 11,600 ton valued at about one crore sixteen lakhs of rupees. This waste represents mor than fifteen percent of our deficit in copra.

**Insects :**

There are a number of insects generally found in copra stores. Corbe et al (1937) reported 26 insects associated with copra in Malaya. However in India, only a few cause serious damage to copra; the rest are only mino pests. A brief description of the principal pests of copra in South India i given below :—

(a) **Necrobin rufipes de Geer.**

**Necrobia** beetle has a world wide distribution and is known as 'Han Beetle' in America and 'Copra Bug' in Pacific. The beetle is generally metalli blue in colour but sometimes with a greenish lustre. Its length varies fron 3.5 to 5.5 mm. The first five joints of the antenna are brown, the rest are black, and the terminal three are expanded. It completes its life cycle ir about 40 days.

(b) **Oryzaephilus surinamensis** L.

This Cucujid beetle is commonly known as Saw Toothed Grain Beetle and it is a serious pest of stored grains, copra and other stored food product throughout the world. The adult beetle is small, flat, elongate, dark brown about 3 mm. in length and 0.75 mm. in breadth. The prothorax has three longitudinal ridges with two depressed areas and its lateral margins are each armed with six prominent teeth like projections. The beetle breeds throughout the year in the moulds and crevices of degenerated copra and completes its life cycle in about 30 days.

### (c) Tribolium castaneum Hbst.

It is commonly known as Red Flour Beetle, and is primarily a pest of cereals like wheat flour, suji and maida, but causes damage to quite a number of other stored products including copra. Passmore (1931) remarked that this was one of the three beetles most prevalent in copra arriving in U.K. The beetle is small, flat, elongated, reddish brown, about 3.5 mm. in length and 1.25 mm. in breadth. The first seven joints of the antenna show a gradual increase in size and the last three are thickened into a club. In India its life cycle varies from 6 to 12 weeks.

### (d) Carpophilus dimidiatus F.

It is the most prevalent insect in copra godowns and mills in Malaya and other coconut producing countries. In India also it is commonly present in copra stores. The beetle is small, flat, broad, and about 3 mm. in length and 1.5 mm. in breadth. It can be readily distinguished from the other beetles by its shorter wing covers, which do not completely cover the abdomen. The beetle completes its life cycle in about 5 weeks.

### (e) Trogoderma granaria Everts.

This pest is known as 'Khapra' in towns and villages of India, and its principal food is wheat. The adults are harmless, and only the grubs are destructive. The beetle is about 3.5 mm. in length and 1 mm. in breadth, and has a characteristic oval shape. The head is proportionately small and is concealed from above by the pronotum. The life cycle in humid places is completed in about two months.

### (f) Ephestia cautella Walk.

This is frequently referred to as the 'Almond' or the 'Fig Moth', and is one of the most important insects infesting dried fruits, cacao, spices, cashewnuts, copra and groundnuts. The moth is about 6 mm. in length and with a wing expanse of 15 mm. Its colour varies with food and environments, but mostly the forewings are greyish brown, somewhat mottled with a distinctly darker coloured transverse band. The average life cycle on mouldy copra is 6 weeks.

### (g) Corcyra cephalonica Staint.

This pest is commonly known as the Rice Moth and is a serious pest of stored paddy, rice, cereals, copra and other stored food products. The head and thorax of the moth are brownish in colour. Forewings are brown wit a pinkish tinge, speckled with darker scales running longitudinally. Hin wings are shiny and silver grey. Wing expanse is about 25 mm.

**Methods of prevention and Control :**

There are a number of measures, which the millers could adopt to preven infestation and control once it has taken root. These measures howeve should be taken at the right time and executed in the right way. In all case the golden rule is that prevention is better than cure.

**(a) Measures to prevent copra becoming infested with insects:**

1. **Preparation of Copra:** It has been generally observed that preferenc is shown by insects for mouldy copra. The reduction of insects associate with copra must therefore commence right from the time of its preparation After splitting, the coconut meat should immediately be subjected to a constan and uniform temperature, so that its moisture content could be reduced t about 6 per cent in the minimum possible time, thereby inhibiting the growt of the fungal moulds.

Most of the copra prepared in India, is by the sun drying method. Thi takes from four to seven days during favourable weather. If there is no rai and the treatment of the copra is not inexcusably careless, this metho produced an article of very high quality. If rain falls while the copra i drying, the latter must be protected against it either by bringing it withi doors or by placing a shelter over it. If such care is not taken, the copra i permanently damaged. Within a few days moulds appear on its surfac which are followed by insects.

2. **Treatment of Bags:** The next important measure is to ensure tha the bags used for the transport and storage of copra are free from insects The theoratical ideal is not to use a bag second time; such a course is however economically not practicable. Therefore all bags should be sterilised by hea or fumigation before use.

A further possibility of solving this problem is offered by the impregnatio of the bags with insecticidal preparations like DDT, DDD and Pyrenone (Pyrethrins with synergist). The chief difficulties in this connection are tha the impregnation must remain effective for a long time, and it must not b accompanied by a risk of contaminating the foodstuffs stored in the treate bags. Butterfield et al (1949) reported that one inch outer layer of fatt foodstuffs enclosed in DDT treated bags, absorbed as much as 100 ppm. DDT

(i) **Heat Treatment of Bags:** The bags should be immersed in boilin water for about two minutes to kill all insects within the bags. The bag afterwards should be turned inside out, and thoroughly dried. Copra bags can also be subjected to dry heat. Corbett et al (1937) have suggested the suspension of the bags on the rafters in copra kilns. Freeman and Turtle (1947) have advised employing of a sack drying plant, circulating a hot air current over the bags.

(ii) **Fumigation of Bags:** This is as efficient as heat treatment, although a higher degree of technical supervision is necessary because to some degree the available fumigants are all toxic to human beings. Of the fumigants available, cynogas is perhaps the most effective, but also the most dangerous to use. The other fumigants generally used are ethylene dichloride, carbon disulphide, chlorosol (a mixture of 3 parts of ethylene dichloride and 1 part of carbon tetrachloride), and methyl bromide. The method of fumigation is described later on.

### (b) Preventive Measures in Copra Mills and Stores:

Serious infestation in copra mills like most other troubles, is far easier to prevent than to remedy. Prevention includes the maintenance of strict hygiene involving the immediate removal of spilage, systematic turnover of stock, regular removal of webbing and cleaning out of all hidden spaces which form breeding places for insects. Another important consideration is that the store is dry and does not leak during rains, so that the copra is kept at such a low moisture content, that insects, mites, moulds and micro-organisms, cannot flourish.

The safest and most effective way of disinfecting ware-houses, stores and godowns, known at present, is to spray the structure with residual sprays of DDT or gamma isomer of BHC. General fumigation is an emergency measure, and the infestation returns to the original level in 3 to 4 months. Treatment of ware-houses with DDT sprays gives a fair protection from most of the pests of copra, for a period of 3 to 4 months. Residual wall treatments with pyrethrum sprays have been found to be surprisingly lasting in cool dark ware-houses, according to Brown (1951).

### (c) Remedial Measures:

It is quite possible that if thorough attention is paid to the measures already suggested, the remedical measures may not be necessary. However, under present day conditions this is seldom possible and control measures are quite often required. Various methods for controlling the insect infestations are employed. Of these, fumigation is the most effective, and this is most frequently employed.

The store to be fumigated should be adequately sealed. A modern building in good condition is easily sealed, and only doors and ventilators may need attention by sealing round their edges. Old or poorly constructed buildings are not suitable for purposes of fumigation. In such cases eithe special fumigation chambers can be constructed or air-proof tarpaulins ca be employed. The safest fumigant for copra is methyl bromide. One poun of methyl bromide for 1,000 cubic feet of space is recommended. Th exposure period is 24 hours. Recently Herford (1954) has reported larg quantities of foodstuffs being fumigated with methyl bromide under specia gas-proof sheets. Some 82,000 tons of groundnuts were treated this way fo control of **Trogoderma granaria** and **Tribolium castaneum** in Nigeria durin 1953.

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# RECENT ADVANCES IN OILSEEDS RESEARCH IN INDIA WITH SPECIAL REFERENCE TO GROUNDNUT, GINGELLY AND CASTOR

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**Oilseeds research has been a comparatively recent development in the country. After the Second World War and the inauguration of the Indian Central Oilseeds Committee, there has been a fillip to the oilseeds research.**

**Research on groundnut, gingelly and castor have been in progress for more than two decades in Madras, Mysore, Hyderabad, Bombay, Uttar Pradesh and Punjab and marked improvement has already been registered. Brief review of the more recent advances in breeding, agronomy, plant protection etc., aspects of these crops together with suggestions for future lines of work are given.**

**The need for pursuing research on these crops has been stressed so that the country may attain self-sufficiency not only in respect of internal consumption but also in the matter of export trade.**

Agricultural Research on an organised basis has been a comparatively recent development in this country. In the early stages of development of agricultural research, attention was mostly paid by the Central Agricultural Research Institute and the State Departments only to the improvement of cereals, pulses, fibres and other crops of the respective regions. Oilseeds crops though of considerable importance from the point of view of local consumption and export trade, did not receive the attention which they deserved till recently. It is only after the commencement of the Second World War when the necessity to establish oil crushing and other industries locally was keenly felt, that the gravity of the situation was realised and attempts were made by the various States to initiate oilseeds research on sound lines. Bringing into existence of the Indian Central Oilseeds Committee marked a new era of development in oilseeds research in India. Several research and development programmes connected with oilseeds have been initiated in a number of States.

Research on oilseeds crops on a fairly systematic basis have now been in progress for more than two decades in Madras, Mysore, Hyderabad, Bombay Uttar Pradesh and Punjab. Within this short period, marked improvement on several aspects of cultivation of oilseeds crops has been recorded. Still greater progress may be expected to be achieved, judging from the keenness with which the States are coming forward to implement research schemes intended to increase production of oilseeds and improve their quality. This paper deals in brief with the more recent advances made in the improvement of the three most important oilseeds crops viz., groundnut, gingelly and castor. Suggestions for future lines of work have also been indicated so that the workers engaged on these crops might have an idea of the more immediate problems confronting the growers and traders.

A large number of exotic and indigenous varieties and species of these crops was collected, grown and studied in great detail over a number of years and from data gathered, systematic classification of varieties, forms, etc., has been attempted. Based on this knowledge the utility of a new variety or a form can be judged and its further maintenance decided. As a preliminary to taking up intensive selection and hybridisation work on these, observation on floral biology and anthesis were carried out at a number of centres and suitable selfing and crossing techniques were evolved. The mode of inheritance of a large number of morphological and economic characters, has also been determined.

### 1. Groundnut:

Though a crop of recent introduction, it has come to occupy a very prominent place in the agricultural economy of the States where it has been introduced. With the knowledge gained in the course of the preliminary studies, intensive selection and hybridisation were carried out with a view to evolving races with high yield, oil content and other desirable agricultural and commercial qualities. Four improved strains in Madras, three in Bombay, three in Uttar Pradesh, eleven in Mysore and two in Punjab, representing bunch and spreading types of groundnut and suited to varying conditions of cultivation have been evolved and are in the stage of large scale multiplication and distribution. They are capable of giving increased yields of 15 to 30% over the local cultivated varieties and also possess other desirable features like drought resistance, high shelling outturn, higher oil content etc. Recently, a dormant bunch strain has also been evolved in Madras and is undergoing rigorous tests under cultivators' conditions. Though the improved strains now under distribution are heavy yielders with good quality produce, still they cannot be claimed to meet the varied requirements of the growers, consumers and industries. As far as growers are concerned there is urgent need to evolve types resistant to drought, pests and diseases, amenable to mechanical cultivation and with short period of seed dormancy. With the increasing edible uses to which groundnut is put, there is demand for a type with low oil and high sugar content. In Vanaspati industry, the need for a type capable of giving colourless, pure oil is keenly felt. For these reasons, breeding of new forms like semi spreading habit of growth, medium seed dormancy, low oil and high sugar content white seed etc., has become imperative.

On the agronomic side, the optimum spacing or seed rate manurial requirements, remunerative mixed cropping practices, efficient crop rotations have been determined in Madras, Mysore, Punjab and other States. In Madras, an optimum spacing of 6″ x 6″ for the bunch and 9″ x 9″ for the spreading types corresponding to a seed rate of 120 lb. and 80 lb. respectively have been fixed while at other centres wider spacing of 12″ and more have been advocated. Increasing the spacing between rows to 1½ feet to 2 feet and reducing the spacing within the row to 3″ to 6″ to facilitate use of labour saving implements for intercultivation and harvest were recently tried in Madras and the results show that the yields are not adversely affected but there is considerable saving in labour charges. Application of potash and phosphoric acid has been found to benefit the crop in most places and the next step lies in fixing up the optimum doses of these and the best method of application suited to different soil types. In laterite soils of the West Coast, where the annual rainfall is over 100 inches and where the soils are deficient in lime, an application of 3 to 4 cwts. of slaked lime as top dressing before the first hoeing and weeding has been found to result in proper pod development and high yield. As the nutritional requirements of this crop are very complex, it is considered very necessary to undertake more thorough investigation on this aspect immediately. Further investigation on three course and four course rotation of crops including groundnut is yet another important agronomic problem awaiting study. The storage aspects of the crop have been investigated in detail in Madras and results of value to growers and trade have been obtained. On the Plant Protection side, effective control measures have been found out for the leaf miner pest (**Stomopteryx nerteria**) and 'Tikka' leaf spot disease. Further trials towards evolving remedial measures for the red hairy caterpillar (**Amsacta albistriga**) aphids, rosette disease, wilt etc., have still to be carried out. Bullock and tractor drawn implements and machinery suited for sowing, inter-cultivation, harvest and threshing have to be designed so that the cost of production of this crop may be maintained at as low a level as possible.

## 2. Gingelly:

Being one of the most ancient among the oilseed crops, it is extensively cultivated in many States of the Indian Union. By selection and hybridisation among the indigenous and exotic varieties, high yielding short duration strains suited to different seasons and conditions of cultivation have been evolved. Three strains in Madras, one in Bombay State and three in Madhya Pradesh are already under large scale distribution. Future lines of improvement would consist in synthesising new forms possessing economic characters like multiloculed nature of fruits, one to three fruits per leaf axil, high oil content, white seed, resistance to pests and diseases etc. Interspecific hybridisation and cytological work pursued at the Indian Agricultural Research Institute, New Delhi, have resulted in evolving types resistant to pests and diseases. Attempts at producing mutant forms of gingelly by X-ray radiation is also under way at the Bose's Institute, Calcutta. These lines of work also require to be further intensified to evolve economic forms with desirable agricultural and commercial qualities. There is also great need to evolve cosmopolitan types that would come up well under a wide range of climatic conditions. The optimum spacing to be adopted for this crop to permit of proper plant development and production has been determined as 9″ x 9″ and 1′ x 1′ for the rainfed and irrigated crops respectively. The cultural and nutritional requirements of the crop have not been seriously studied at any centre in India. If the present low yields from the crop are to be stepped up, these aspects should receive immediate attention. Though some control measures for the Shoot-Webber (**Antigasta catalaunalis**) pest have been found out and recommended, still they are not as effective as they should be. Very effective control measures have to be devised not only for this but also for the gall fly pest and 'Phyllody' disease.

### 3. Castor:

The attention paid to this important oilseeds crop has not been commensurate with its international status. Only Madras and Hyderabad have done some work on its improvement. In breeding, selection and hybridisation carried out with the collection of varieties from different parts of the world have resulted in evolving three improved strains in Madras, seven in Hyderabad, one in Bombay and two in Madhya Pradesh. These strains are capable of giving marked increase in yield over the local cultivated varieties and also have high oil content. TMV.2 strain from Madras is also claimed to be a non-dehiscent type that would prevent loss due to shedding. Another perennial type or three castor (Co. 1) has also been evolved in Madras with high oil content (55%). A special technique for the maintenance of vigour and purity of improved strains of castor have been evolved in Madras. As expression hybridisation is found somewhat pronounced in certain combination of crosses, utilisation of this phenomenon for production of commercial hybrids seems to be a worth while project. Since this line of work has advanced in America, the techniques adopted there would be of great value to the workers in this country in initiating similar work. There is also urgent need to bring down the duration of the crop by about two three months by hybridisation between selected parents. The recent American and African introductions seem to be the proper breeding material for this purpose. The problem of capsule dehiscence also requires careful study so that the strains proposed to be evolved in future may have non-dehiscent character of the fruits.

The optimum spacing for the crop grown pure has been determined both in Madras and Hyderabad. Though a 3′ x 3′ spacing is recommended in Madras a comparatively narrow spacing of 3′ x 14″ is advocated in Hyderabad. presumably due to poor soil conditions under which this crop is raised. The exact cultural and manurial needs of the castor crop under varying soil conditions have yet to be determined though Hyderabad has been recommending an application of 30 lbs. nitrogen in the form of either farm yard manure or castor cake based on certain preliminary trials. The best quality beans is obtained when fruit clusters are harvested at full maturity and dried immediately after harvest instead of curing them in stacks for some time. Among the pests affecting this crop the Semilooper caterpillar (**Achoea janata**) is the most devastating and finding out an effective control measure for this pest would greatly aid successful cultivation of this crop.

From the above review it would be evident that oilseeds research in India has no doubt been pursued with zeal in recent years and already results of far reaching importance have been obtained. If this country is to develop her industries and provide adequate nutrition to the people, it is most urgent and necessary that the research programmes already undertaken should be carefully planned and executed, so that further progress on the different aspects may be rendered possible and the country taken towards self-sufficiency. As the aim of the Second Five-Year Plan in respect of oilseeds is not only to meet the internal demand but also to have adequate surplus for export, it is all the more necessary that the different States and Institutes engaged in oilseeds research should strive for better progress than has hitherto been possible.

# FAT FROM MOLASSES

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The outlet for the very large amounts of molasses produced by our sugar factories in India has been mainly for production of alcohol. With the advent of more sugar factories and with more cane being grown in India, utilization of molasses solely for manufacture of industrial alcohol is neither economical to the industrialist nor beneficial to the country. Ways and means must be found to use the molasses to produce more important fermentation products. One such use is the production of fat-rich yeast from which the fat can be extracted, the residue also being used as a rich source of protein. A number of yeasts have been tried for this purpose, like **Endomyces vernalis, Oidium lactis, Torulopsis lipofera** and **Rhodotorula gracilis.** Of all these **R. gracilis seems to be the best,** since it grows efficiently under submerged conditions and has both a high fat content and a high fat coefficient (parts of fat obtained per 100 parts of sugar used). **R. gracilis** has wider tolerance for nitrogen; the fat content does not alter much with moderately higher concentrations of nitrogen. This is important since many commercial carbohydrate materials, like molasses, in themselves contain nitrogen.

Prof. Lundin and his associates of the Royal Technical University, Stockholm have done extensive work on the cultivation of **R. gracilis** for fat synthesis. Inverted cane sugar, Blackstrap molasses etc., have been shown to be suitable for the production of the fat-yeast.

Under suitable conditions **R. gracilis** contains 50-60% fat (on dry wt.) with a fat coefficient of 16-19. The composition of the fat is given in Table I.

**TABLE I.**

| | | |
|---|---|---|
| **Saturated acids % :—** | Myristic | 1.1 |
| | Palmitic | 29.8 |
| | Stearic | 8.8 |
| | Others | 1.4 |
| **Unsaturated % :—** | Hexadecenoic | 1.8 |
| | Oleic | 40.1 |
| | Linoleic | 11.2 |
| | Linolenic | 4.8 |
| | Saponification value | 295 |
| | Iodine value | 79 |
| | Unsaponifiable matter | 3.10 |

The oil is suitable for both edible purposes and soap manufacture.

In our experiments we have found that **R. gracilis** can be grown efficientl in a medium prepared from molasses produced by the Mandya Sugar Factory Fat contents upto 55% of the dry yeast and fat coefficients of 17-18 wer obtained in laboratory scale experiments with 1 to 20 liters of medium.

Molasses is first diluted to about 8% sugar concentration and the pH adjusted to about 3.5 with sulphuric acid. when the calcium in molasses i precipitated out as $CaSO_4$. The clear supernatant liquid is drawn out and further diluted to 3% sugars and fortified with 0-1% of $(NH_4)_2SO_4$ and 0.1 $KH_2PO_4$. This medium is boiled for 20-30 minutes to hydrolyse the sucros (the yeast can use glucose very much better than sucrose), cooled and inocu lated with 10% of actively growing culture of **Rhodotorula gracilis.** Aeratio is now started and continued for 60-72 hours when the growth of yeast and accumulation of fat in the yeast cells is complete. After completion of the growth and fattening phase. the yeast suspension goes via a storage tank t a battery of separators, where it is defoamed. First, however, the yeas suspension is diluted with water to a concentration of 1% (dry weight) yeas and the fluid is subsequently separated three times. After each separatio but the last, it is diluted again (about 10 times) to a concentration of 1% yeast The approximate 10% yeast suspension, having been washed after the thir separation. is then brought to a vacuum evaporator, where it is evaporate and autolysed at about 50-70°C. to a dry yeast content of about 20-25% Finally, it is treated in a spray of vacuum-drum dryer to a moisture conten of 8%. For recovery of fat, the dried yeast is extracted with a suitable solven like petroleum ether or alcohol. The usual Soxhlet apparatus is used fo laboratory extractions. but on an industrial scale, any of the well-known solven extraction machinery may be used. The fat so abtained is yellowish-red i colour and has a pleasent aroma. The residue is rich in protein and B-vitamins and could be used as a food or fodder yeast. A typical set of results is give below :—

## TABLE II.

| | |
|---|---|
| Volume of nutrient medium (liters) ... ... ... | 2 |
| Sugar used (molasses) (grams) ... ... ... | 60 |
| Time of cultivation (hours) ... ... ... | 72 |
| Yeast produced (grams) ... ... ... | 20 |
| Yield of yeast (% on sugar used) ... ... ... | 33.3 |
| Fat content of dry yeast (%) ... ... ... | 50 |
| Fat produced (grams) ... ... ... | 10.2 |
| Fat coefficient ... ... ... | 17 |
| Fat obtainable from 1 gallon of mollasses ... | nearly 1 lb. |

The oil extracted from the hydrolysed yeast is red in colour (because of dissolved carotene) and has a pleasant odour.

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3. Lundin, H., J. **Inst. of Brewing,** LVI, (1950), 17.
4. Freto Torengvest, & Lundin H., **International Sugar Journal,** (1951). 123.

# FAT PRODUCTION BY MICROBIAL FARMING

**Om Prakash & B. D. Seth.**
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**Production of fats by the action of certain micro-organisms has been reviewed. Various important aspects of the problem as the choice of micro-organisms, conditions of fat formation, chemistry of fat formation, industrial cultivation of micro-organisms and recovery of fat etc. have been dealt with. Work on the production of synthetic fats by micro-organisms using cane molasses as substrate offers scope for development.**

Several micro-organisms, when grown on suitable substrate, produce fats. Production of fats from carbohydrates assumed great importance in Germany in the first world war. Commercial utilisation of the process, however, appears to have achieved some success only during the second world war.

The original observations upon which the process of fat biosynthesis rests were made by the distinguished biologist Pal Lindner (1) who described his work in a publication that appeared after the first world war. He discovered a fat yeast — a Torula, and also discovered the fat forming capacities of **Endomyces vernalis.** He also found out the basic requirements of bio-synthesis of fats. Lindner developed two processes, a tray process and a floor process, but could not operate any of the processes on a commercial scale on account of the excessive cost. In 1937 Flink et. al. (2) confirmed Lindner's findings in regard to **Endomyces vernalis** and also extended them to **Oidium lactis,** which seemed to be another promising organism.

In the years proceeding and during world war II numerous attempts were made to establish a commercial process of fat bio-synthesis but without much success. However, important forward strides were made and processes involving submerged culture were developed by Damma (3) and Shimidt (4) who used Torula and Fusaria respectively. In recent years the problem has attracted the attention of many research workers. Nokey (5) in 1951 obtained a yield of 27.4% of fat on the weight of carbohydrates in molasses by applying **Rhodotolura gracillis.** Nakahama and Ishida (6) in 1952 reported a yield of 47% fat from fermented potato mash by employing organisms of the species of **Endomyces** or **oidium.**

Various yeasts, moulds and fungi, are known to synthesise fat. Important amongst these are :

1. **Yeasts — Saccharomyces** such as **Torula utilis, Rhodotorula glutinis, Rh. gracilis, Endomyces vernalis.**

2. **Moulds — Oidium** (oospora), **Penicillium, Aspergillus** and **Mucor** such **oidium lactis, Penicillium Javanicum, Aspergillus niger** and **fischeri, Spinosus** and **Stolonifer** and **M. Mucedo.**
3. **Fungi — Fusarium,** and as **Fusarium liai** and **F. lycopersici.**
4. **Freto Torengvest,** and **Lundin, H.,**

The characteristic properties of fats synthesised by these classes of organisms are summarised in the table below :

**Conditions of fat formation :**

The conditions of fat formation by micro-organism have been well studie and some of the important factors that govern the process are — supply o abundant sugar, oxygen supply, temperature, pH, presence of phosphates an vitamins.

The fat-forming micro-organisms assimilate sugar and do not ferment it While sugar is the basic raw material in the synthesis of fat by micro-organisms, fat is reported to have been synthesised by some micro-organism on non-sugar substrates also.

Fat synthesis from carbohydrates by the micro-organisms like **Endomyce vernalis** and **Fusarium** which have been studied in detail is enhanced by good supply of oxygen. A sufficient quantity of oxygen has to be supplie either by cultivating the organism on large surfaces or providing them wit oxygen under pressure.

Optimal fat formation depends upon the growth temperature of th particular organism and pH of the medium which in the case of Torula ar 32 to 34°C. and 5.5 respectively. Temperature also plays an important par on the chemical characteristics of the fat formed.

Phosphates are essential in fat synthesis. Experiments conducted o baker's yeast show that formation of fat decreased in the absence of phosphates. In similar experiment on **T. cipofera** maximum fat formation proceed in the presence of phosphates. These experiments also point out tha phosphate is required for carbohydrate breakdown in the medium.

Other factors which have been found to affect the synthesis of fat are ag of the culture, and concentration and existence of ions like magnesium, calciu and sulphate. In certain micro-organisms, magnesium and calcium increas fat formation while in others fat formation is inhibited by these salts.

Thiamin, riboflavin, pyridoxine, pantothenic acid and biotin have bee shown to play a role in fat synthesis. Thiamin generally augments th amount of fat formed, but in **T. lipofera** addition of this vitamin has no effe on fat formation.

## Chemistry of fat synthesis :

The synthesis of fat by micro-organisms has been discussed by several workers (2, 8, 13) but has not been well understood.

The following appear to be probably true :

(a) Microbial fats are synthesised from carbohydrates similar to vegetable and animal fats.

(b) Glycerol is formed as in alcoholic ferementation.

(c) Synthesis of neutral fat from fatty acids and glycerol involves the activity of lipase.

Many details, however, remain to be investigated in this direction. Little is known concerning the mode of synthesis of constituents that accompany the fat such as phosphatides, sterols and carotenoids.

It has not been established as to whether the excess of free fatty acid in microbial fat is due to the disturbance in the equilibrium of synthesis or to deficiency of glycerol. According to Reichel the effect of different components causing a shift of equilibrium varies with their relative concentration and so glycerol excess should bring about greater synthesis and excess of water should favour hydrolysis. Many workers have recognised two distinct phases in the synthesis of fat by micro-organisms. One is protein generation in presence of high nitrogen and low carbohydrate concentrations and the other a fat generation phase in the presence of high carbohydrate and low nitrogen concentration in the presence of abundant supply of air.

## Industrial cultivation of micro-organisms :

As already indicated, although synthesis of fat from micro-organism was known since a long time, yet its commercial exploitation was attempted only during the world war II. The success of the commercial fat synthesis depends on the following factors :

1. Choice of a suitable micro-organism.
2. Establishment of a cheap but suitable culture medium.
3. Development of a suitable cultivation method.

Three general methods of cultivation have been suggested :

1. Growth on surface of liquids — Tray method.
2. Growth on solid surfaces — Floor method.
3. Submerged growth in aerated tanks — submerged cultivation.

Of the above methods, submerged cultivation appears to be the most economical on account of less space requirement, lower labour cost and simpler equipment. Moreover in this process contamination hazard is minimum. Many investigators, who have concentrated on this process, however, did not meet with much success. This may not be ascribed to difficultie of equipment etc. but to the inability of the organism to grow well unde submerged conditions and produce adequate quantity of fat. It is however not possible to make a rule as far as the selection of cultivation methods are concerned but it has to be chosen according to the habit of the particula organism to be worked upon. Similarly, no general formulae can be prescribed for the culture medium as it has to be chosen with reference to individual organism.

**Recovery of fat from the organism and its possible uses :**

Recovery of fat from the micro-organism presents a number of difficulties. Complete extraction without previous destruction of the cell structure is not possible due to the binding of the fat to proteins.(13) Usually three methods are being followed for this purpose :

(i) grinding of the dried mycellium with sand and subsequent extraction with ether

(ii) treatment with dilute HCl.

(iii) autolysis at 50°C.

In the first procedure decomposition of the fat to the extent of 25% results and as such the fat is not suitable for edible purposes. The other two processes yield fat fit for edible purposes.

In India, where large quantities of cane molasses are available, the process of fat synthesis by micro-organism appears to present a good scope for development. Work has, therefore, been undertaken and cultures have isolated and obtained. Conditions of microbial farming of fat from molasses are being studied, with facilities available in the biochemical section of the Indian Institute of Sugar Technology, Kanpur.

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### Table I.

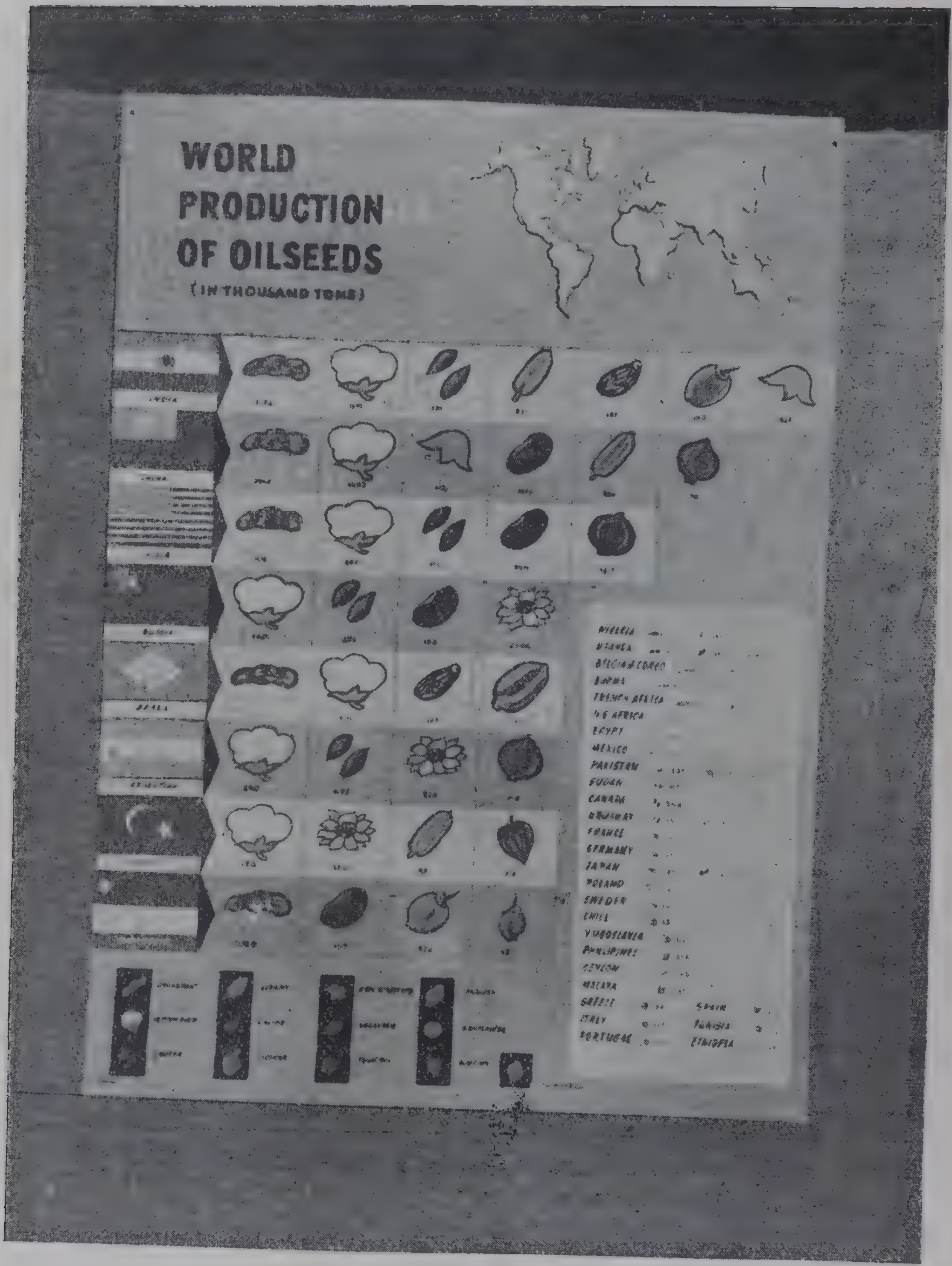
| Source | Solidification temp. °C. | Sap. No. | Acid No. | Iodine No. | Unsaponifiable matter % |
|---|---|---|---|---|---|
| 1. Pencillium Javanicum (7) | 6-7 | 191-192 | 10.5 | 84. | — |
| 2. Aspergillus niger (8) | — | 169 | 71.2 | 95.1 | — |
| 3. Endomyces vernalis (9) | —10 | 185 | 13.0 | 96 | — |
| 4. Endomyces vernalis (9) | Solid | 238 | 30%* | 65 | — |
| 5. Endomyces vernalis (9) | Liquid | 229 | 23%* | 195 | — |
| 6. Oidium lactis (4) | — | — | — | 63 | — |
| 7. Oidium lactis (10, 11) | — | 193.8 | 6.11 | 46.8 | — |
| 8. Oidium lactis (10, 11) | — | 198.0 | 4.53 | 72.8 | — |
| 9. Fusarium (12) | Liquid | 189.3 | — | 84.7 | 2.1 |
| 10. Fusarium (3) | Liquid | 190-196 | 0.5-4.0 | 79.90 | — |
| 11. Torula utilis | — | 180.7 | 102.4 | 120.5 | 12.3 |
| 12. Yeast (12) | — | 162 | — | 71.1 | 15.6 |
| 13. Peanut oil | — | 183-197 | — | 89-98 | — |
| 14. Olive oil. | —6 | 182-188 | — | 87-88 | — |

* = f.f.a.

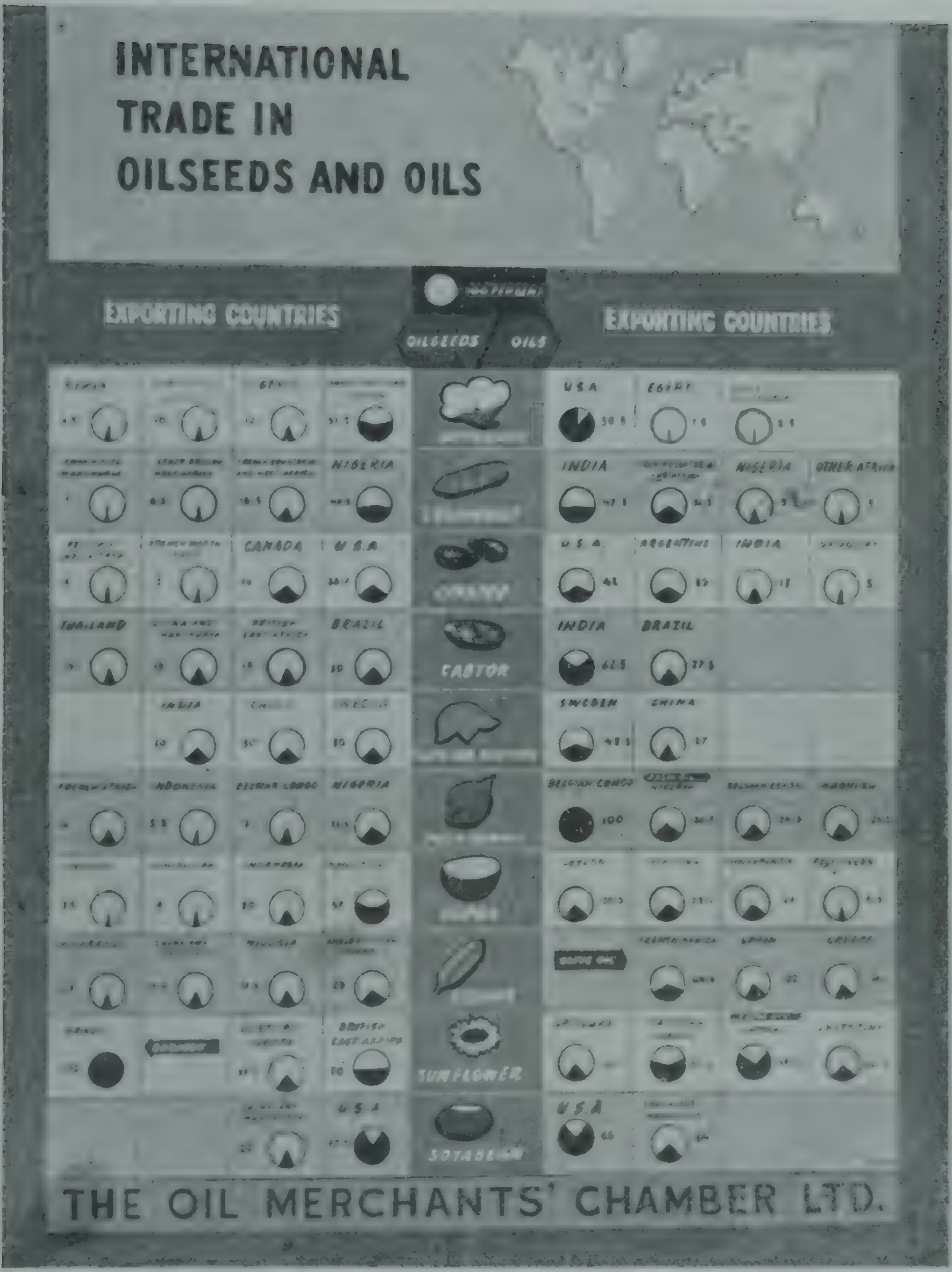
— END —

# EXHIBITION

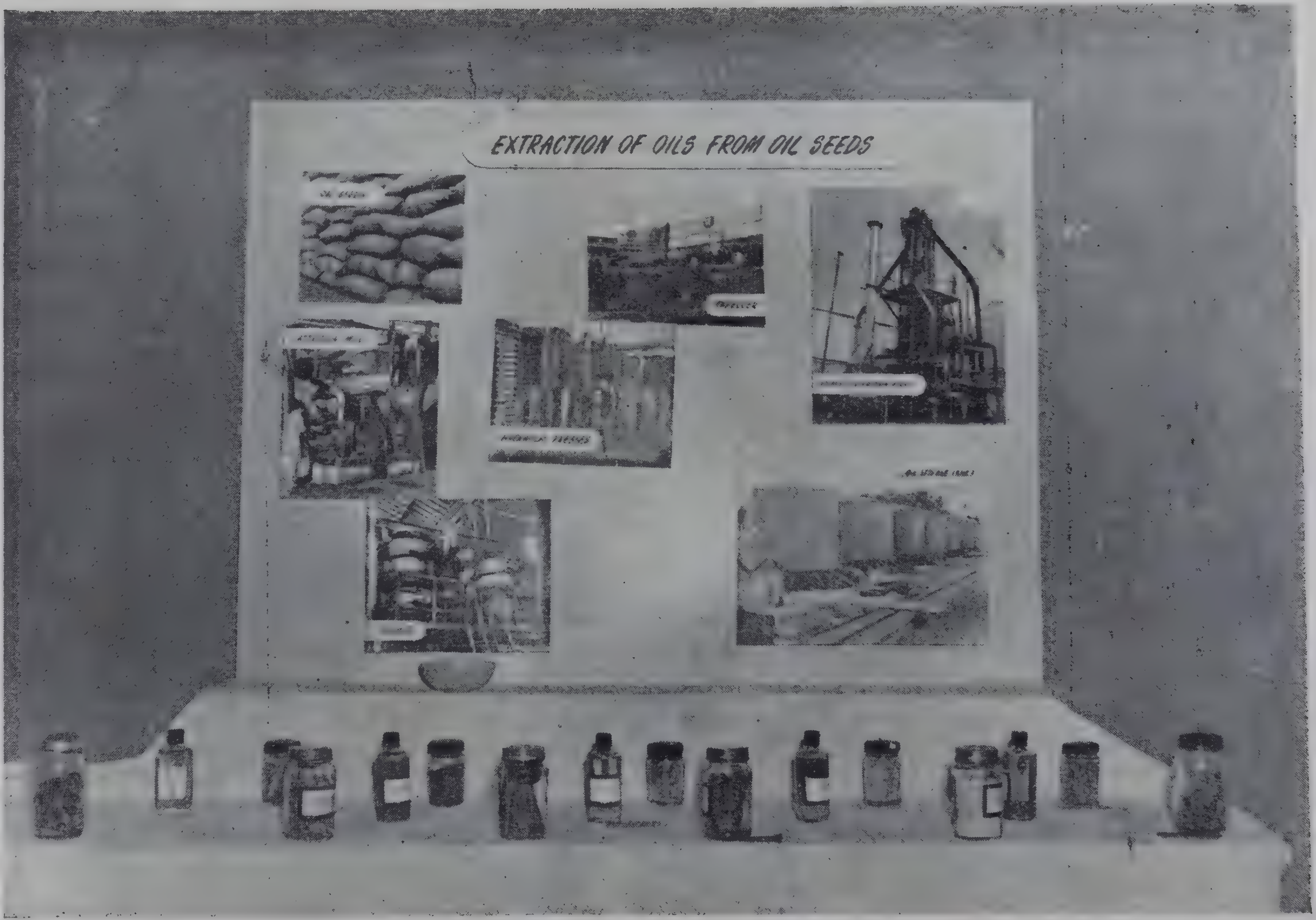
कश्मीर
पंजाब
राजस्थान
बिहार
मध्य प्रदेश
बम्बई
हैदराबाद
मद्रास


WORLD PRODUCTION OF OILSEEDS
(IN THOUSAND TONS)
INDIA
NIGERIA
UGANDA
BELGIAN CONGO
BURMA
FRENCH AFRICA
EGYPT
MEXICO
PAKISTAN
SUDAN
CANADA
URUGUAY
FRANCE
GERMANY
JAPAN
POLAND
SWEDEN
CHILE
YUGOSLAVIA
PHILIPPINES
CEYLON
MALAYA
GREECE
ITALY
PORTUGAL
SPAIN
TUNISIA
ETHIOPIA

IV


INTERNATIONAL TRADE IN OILSEEDS AND OILS
EXPORTING COUNTRIES
OILSEEDS
OILS
EXPORTING COUNTRIES
NIGERIA
CANADA
U.S.A.
THAILAND
BRAZIL
BRITISH EAST AFRICA
INDIA
NIGERIA
BELGIAN CONGO
NIGERIA
BRAZIL
BRITISH EAST AFRICA
U.S.A.
CASTOR
SUNFLOWER
SOYABEAN
U.S.A.
EGYPT
50.5
INDIA
NIGERIA
OTHER AFRICA
47.5
U.S.A.
ARGENTINE
INDIA
42
17
5
INDIA
BRAZIL
62.5
27.5
SWEDEN
CHINA
17
BELGIAN CONGO
100
FRENCH AFRICA
SPAIN
GREECE
U.S.A.
66
THE OIL MERCHANTS' CHAMBER LTD.

V



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VI

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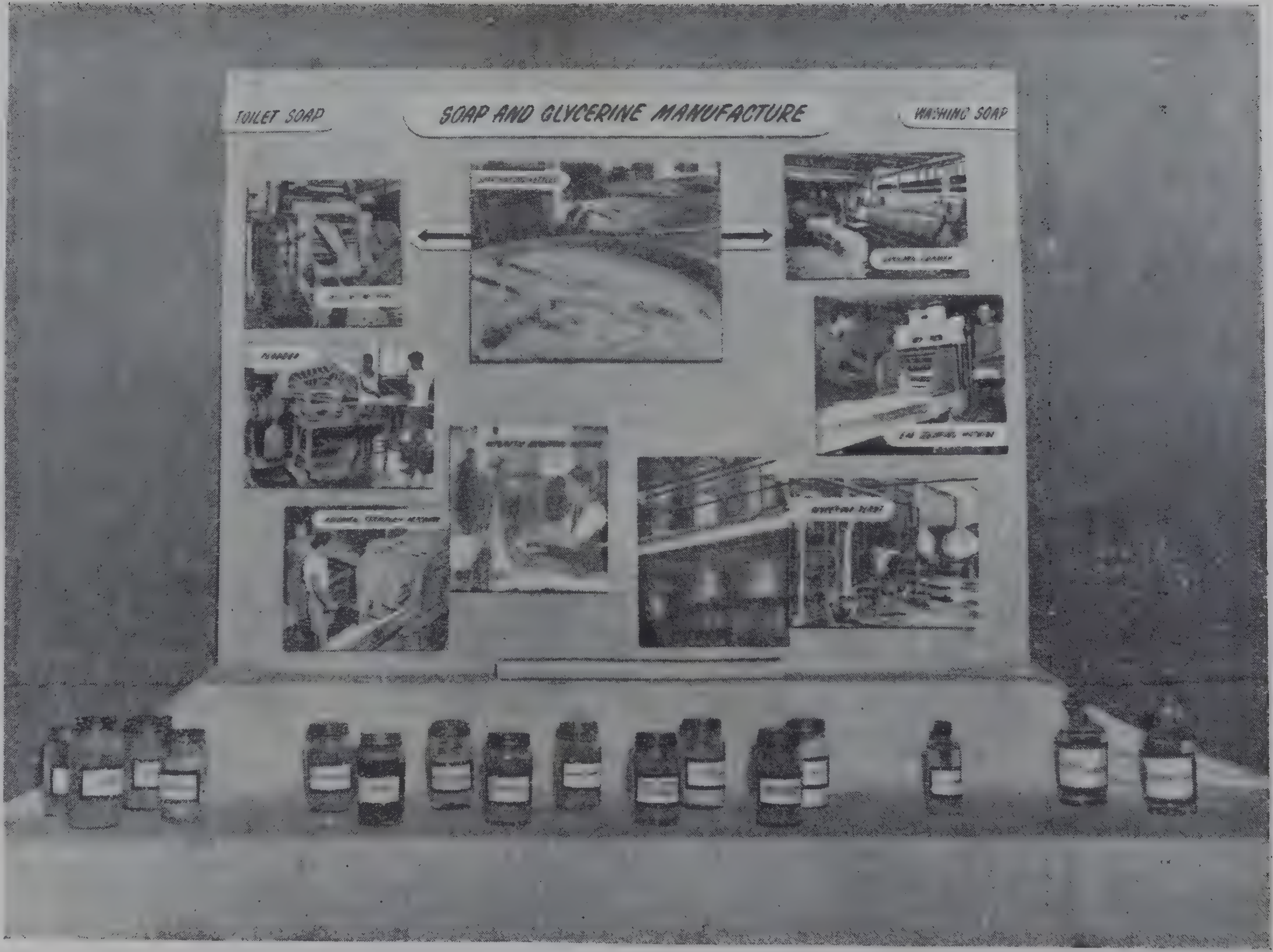

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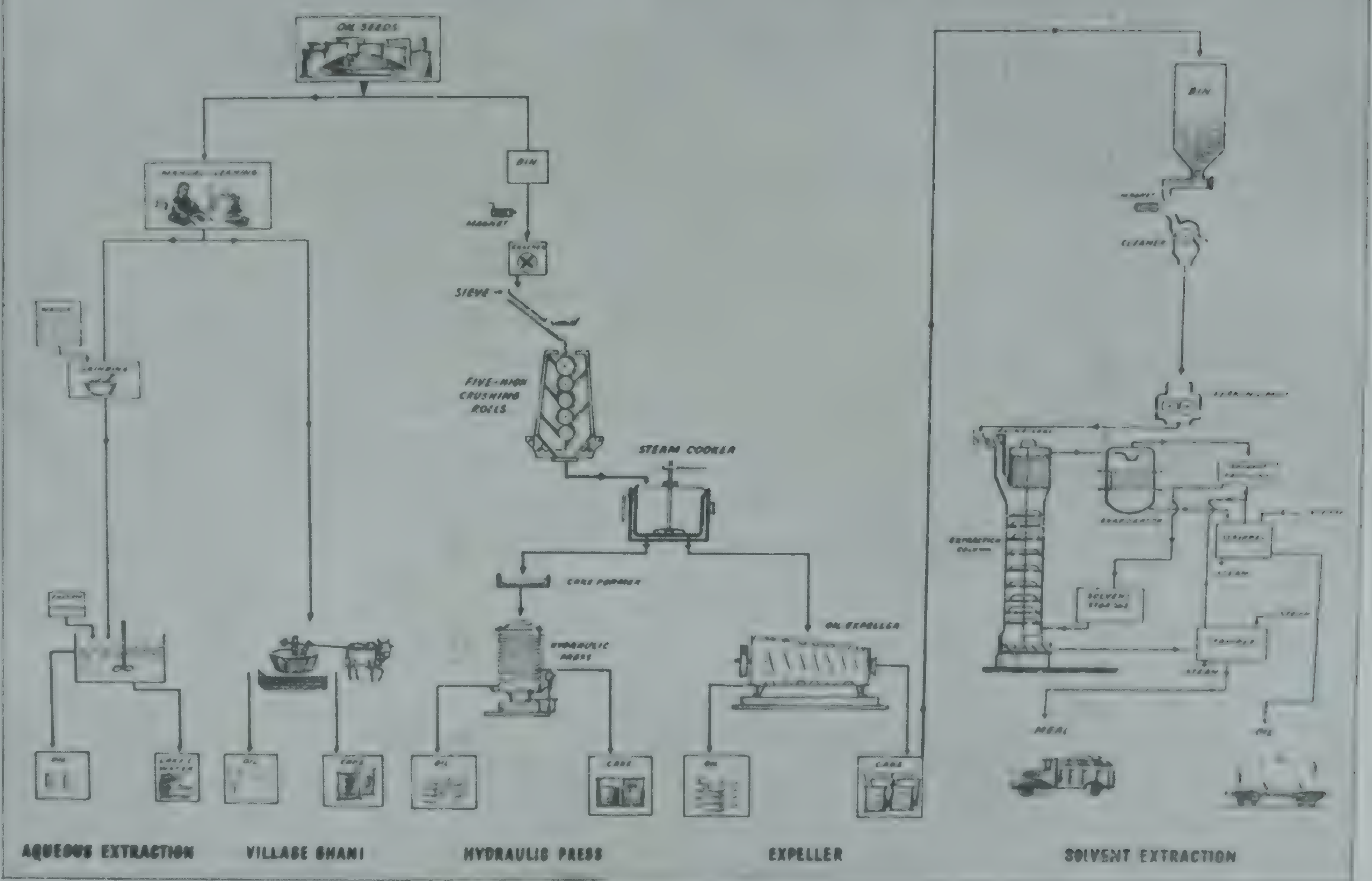
VIII

# DIFFERENT METHODS OF EXTRACTION OF OILS



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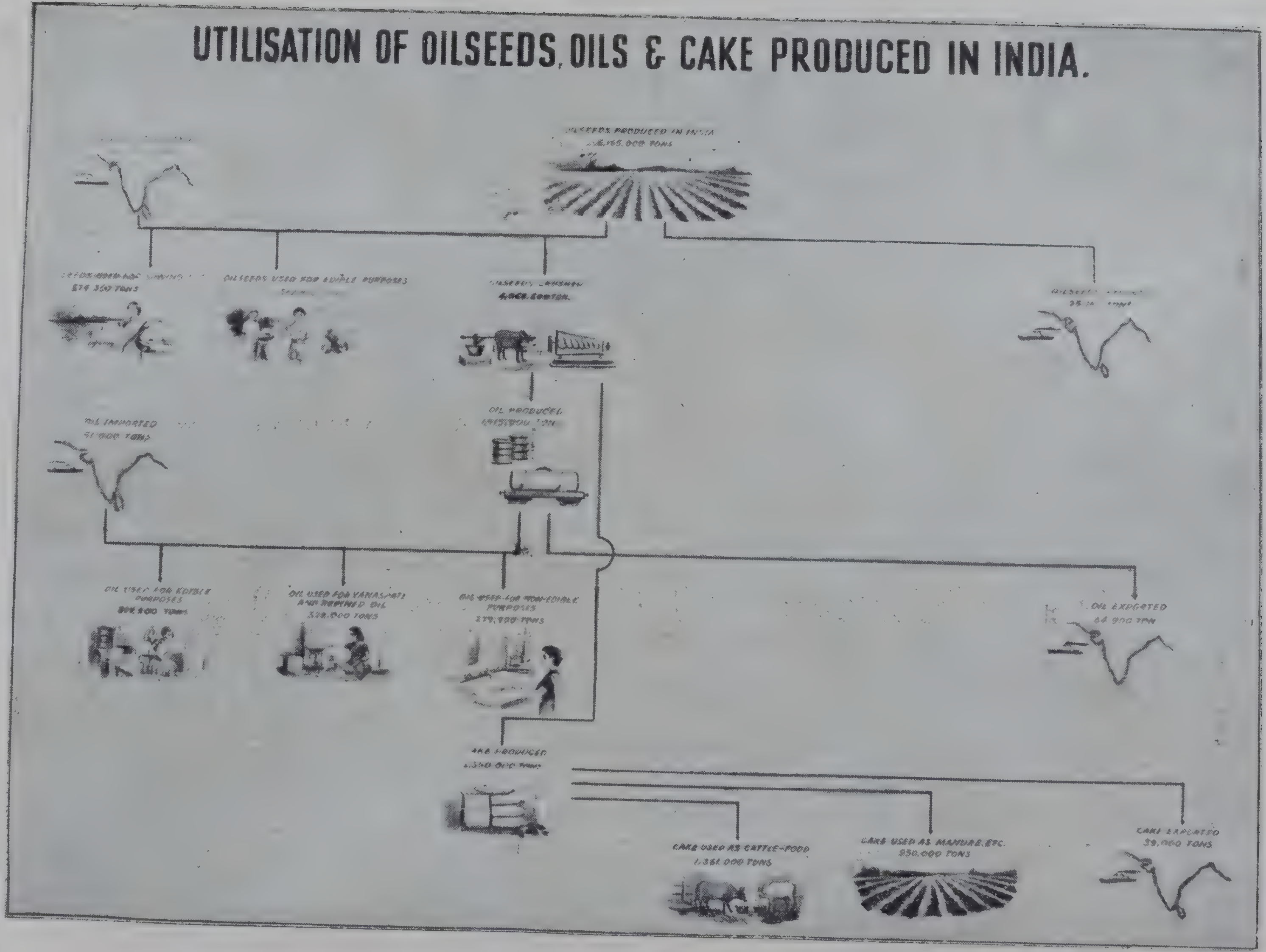

UTILISATION OF OILSEEDS, OILS & CAKE PRODUCED IN INDIA.

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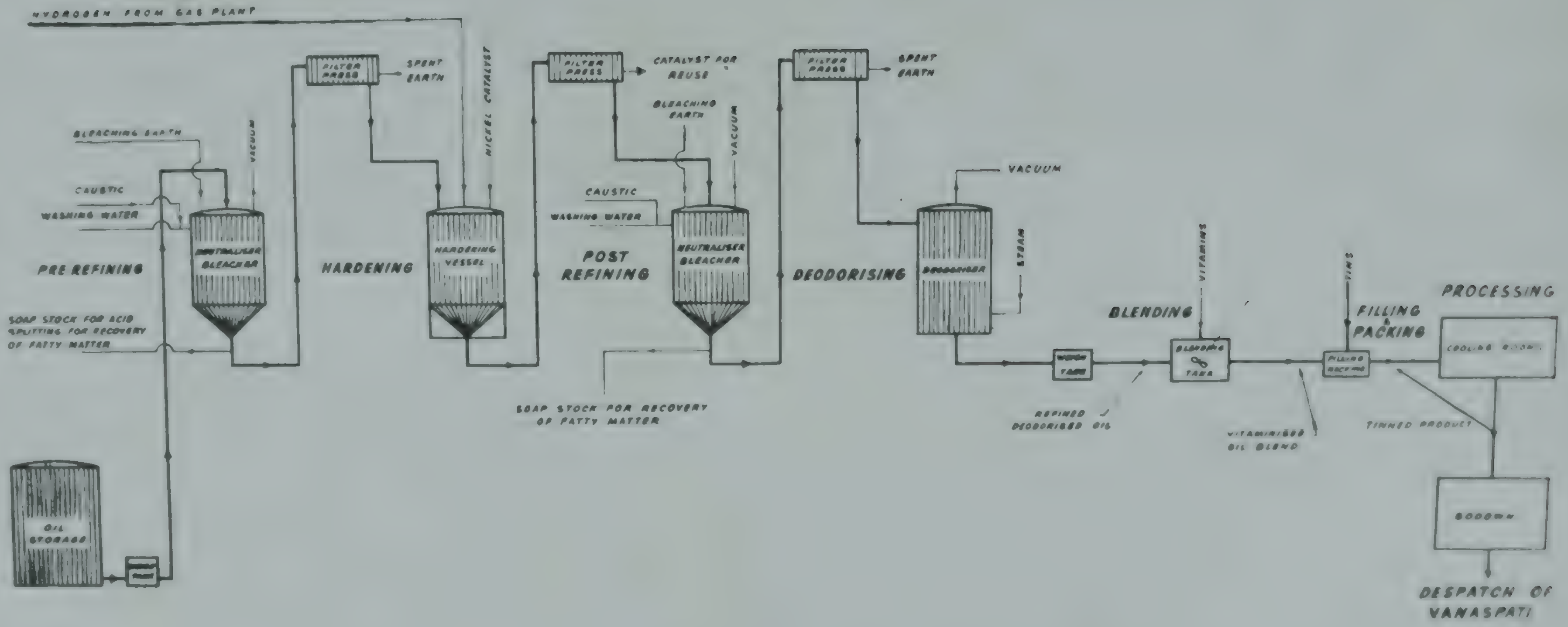
# MANUFACTURE OF VANASPATI FROM VEGETABLE OILS



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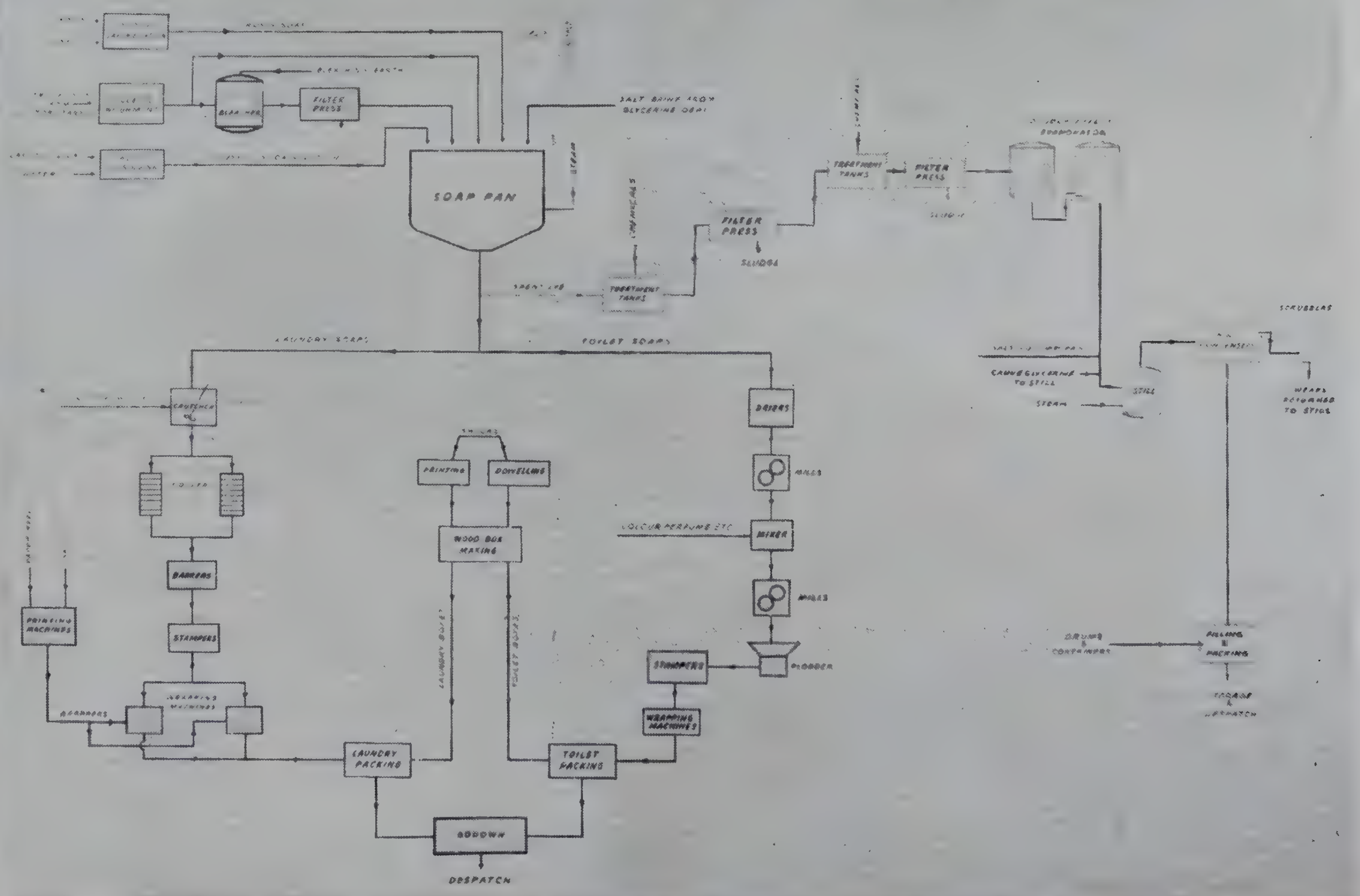
# MANUFACTURE OF SOAP & GLYCERINE FROM VEGETABLE OILS



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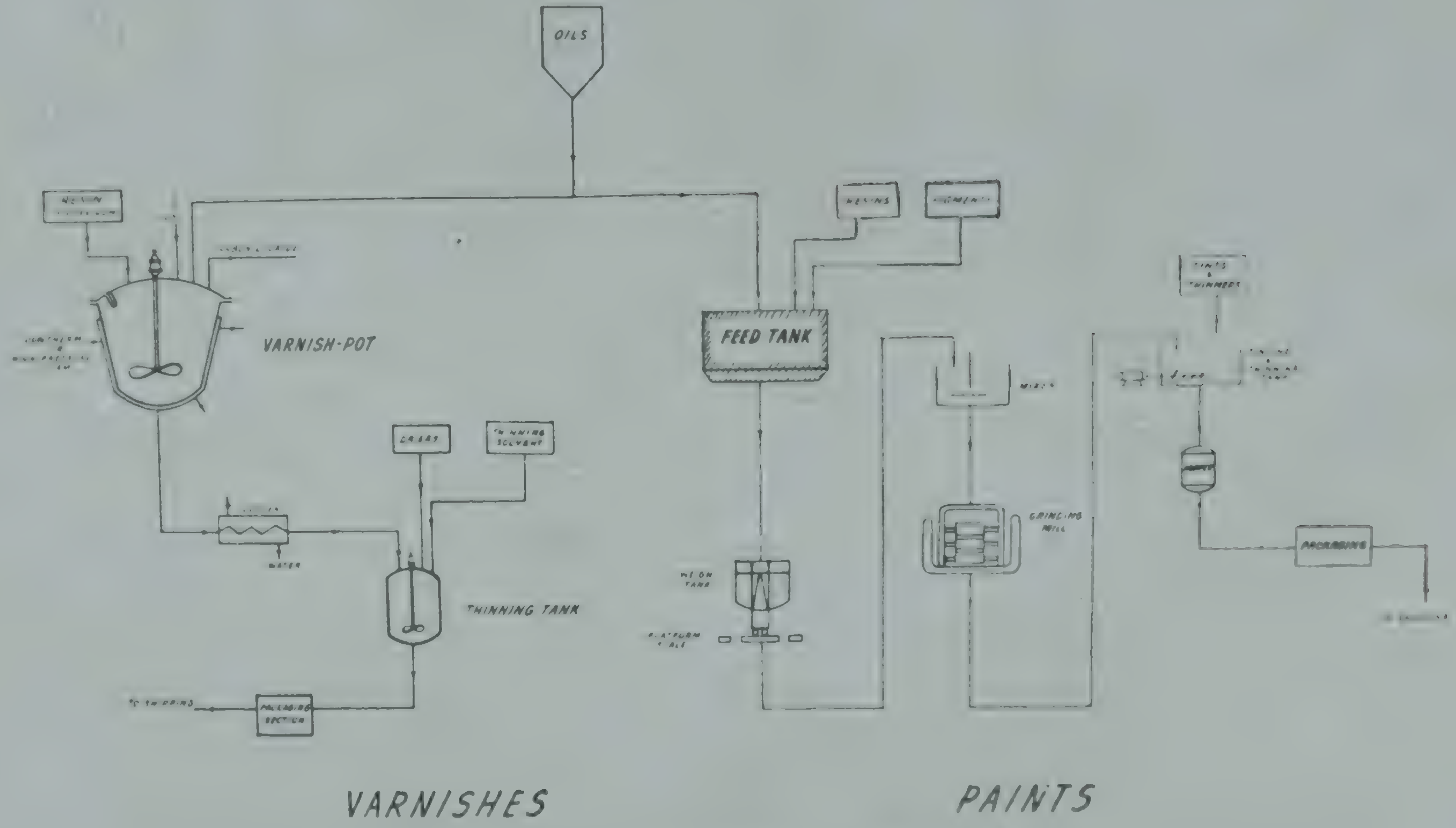
# MANUFACTURE OF PAINTS AND VARNISHES FROM VEGETABLE OILS



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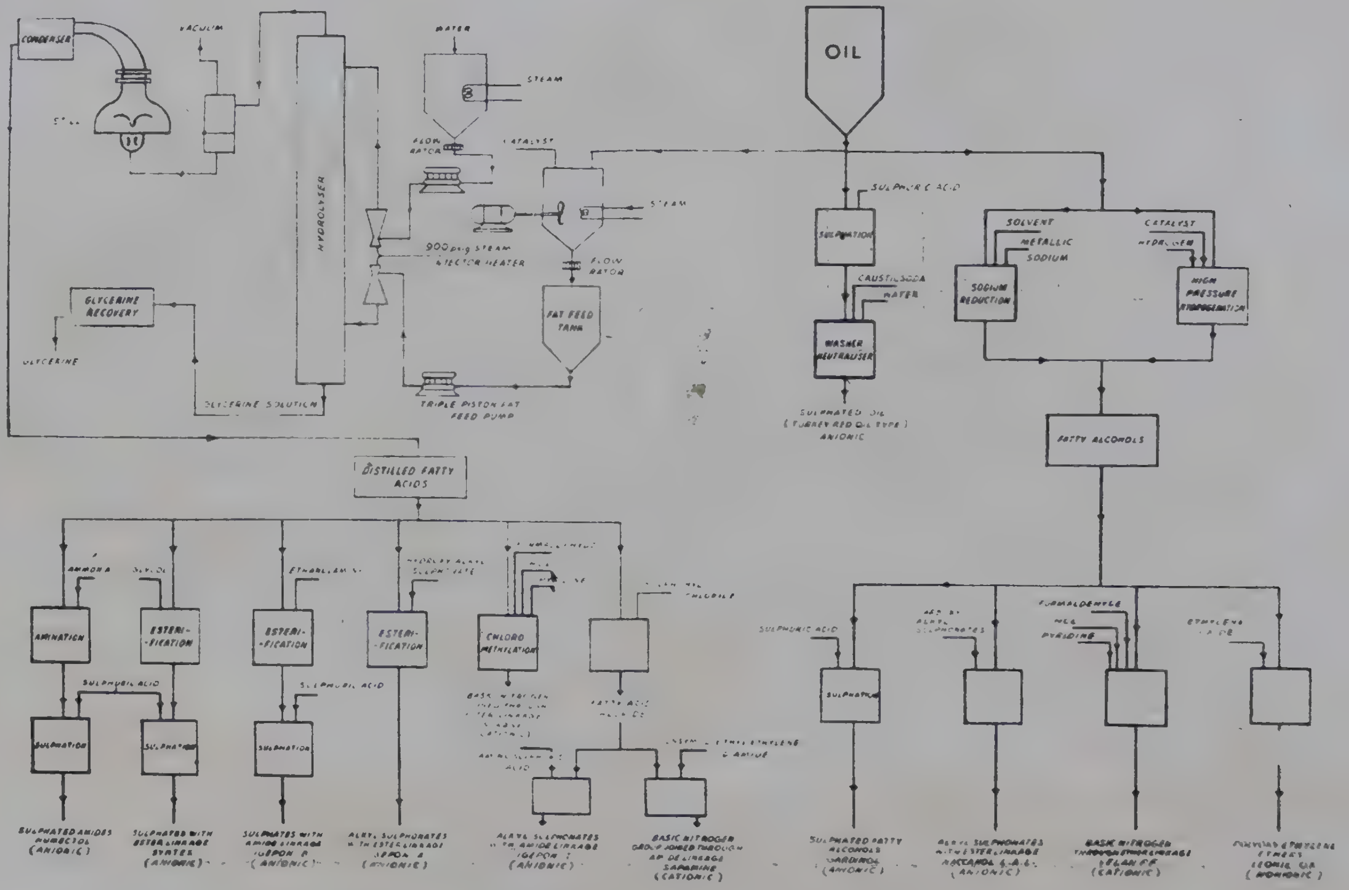
# MANUFACTURE OF FATTY ACIDS AND NON-SOAPY DETERGENTS FROM VEGETABLE OILS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HYDROLYSER
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STEAM
FLOW RATOR
CATALYST
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FLOW RATOR
FAT FEED TANK
GLYCERINE RECOVERY
GLYCERINE
GLYCERINE SOLUTION
TRIPLE PISTON FAT FEED PUMP
DISTILLED FATTY ACIDS
OIL
SULPHURIC ACID
SULPHATION
CAUSTIC SODA
WATER
WASHER NEUTRALISER
SULPHATED OIL (TURKEY RED OIL TYPE) ANIONIC
SOLVENT
METALLIC SODIUM
SODIUM REDUCTION
CATALYST
HYDROGEN
HIGH PRESSURE HYDROGENATION
FATTY ALCOHOLS
AMMONIA
GLYCOL
ETHANOLAMINE
AMINATION
ESTERI-FICATION
ESTERI-FICATION
ESTERI-FICATION
CHLORO METHYLATION
SULPHURIC ACID
SULPHURIC ACID
SULPHATION
SULPHATION
SULPHATION
CHLORIDE
FATTY ACID
ETHYLENE AMINE
SULPHATED AMIDES HUMECTOL (ANIONIC)
SULPHATES WITH ESTER LINKAGE (ANIONIC)
SULPHATES WITH AMIDE LINKAGE IGEPON A (ANIONIC)
ALKYL SULPHONATES WITH ESTER LINKAGE IGEPON A (ANIONIC)
ALKYL SULPHONATES WITH AMIDE LINKAGE IGEPON T (ANIONIC)
BASIC NITROGEN GROUP JOINED THROUGH AMIDE LINKAGE SAPAMINE (CATIONIC)
SULPHURIC ACID
SULPHATION
FORMALDEHYDE
HCL
PYRIDINE
ETHYLENE OXIDE
SULPHATED FATTY ALCOHOLS GARDINOL (ANIONIC)
ALKYL SULPHONATES WITH ESTER LINKAGE NACCANOL L.A.L. (ANIONIC)
BASIC NITROGEN THROUGH ETHER LINKAGE VELAN PF (CATIONIC)
POLYGLYCOL ETHYLENE ETHERS LEONIL OR (NONIONIC)

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